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FIFTH ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY

OF

PENNSYLVANIA.

BY HENRY D. ROGERS,
STATE GEOLOGIST.

HARRISBURG:
JAMES S. WALLACE, PRINTER.
1841.

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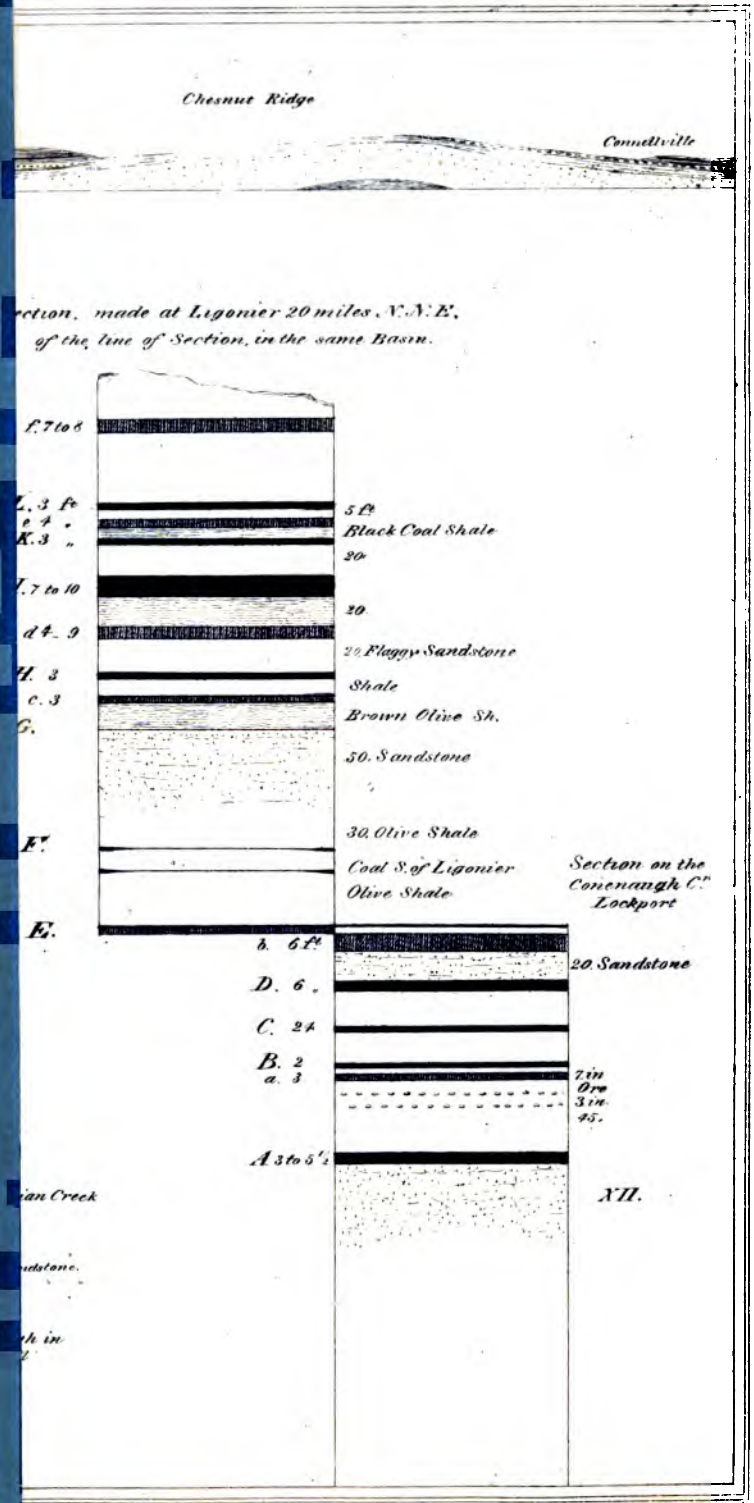

ection, made at Ligonier 20 miles N.N.E. of the line of Section, in the same Basin.

P. S. Duval, Lith. Philad.

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REPORT.

To the Secretary of the Commonwealth:

Sir:—In compliance with the Act of Assembly, requiring the State Geologist to submit to the Legislature, an annual account of the progress of the Geological Survey, I beg leave to present the following Report:

From the middle of April until about the same period in November, the active field operations of the survey were diligently prosecuted; the explorations lying chiefly in parts of Monroe, Northampton, Lehigh, Schuylkill, Berks, Lebanon, Dauphin, Northumberland, Perry, Mifflin, Franklin, Huntingdon, Bedford, Somerset, Cambria, Fayette, Westmoreland, Centre, Clearfield, Venango, Erie, Crawford, Mercer, Butler and Greene counties. Though the detailed examination of several of these counties is yet to be completed, a considerably larger area of the State, was minutely examined, than during any former season.

Guided by the previously acquired insight into the stratification of the rocks, and the true relative position of their contained mineral beds, and assisted by increased experience and skill, on the part of those engaged in the survey, in detecting and tracing the more obscure deposites, we have succeeded in bringing to light much that was before entirely unknown, and settling many points that were doubtful in the economic geology of several of these districts. Thus, where hitherto, no accurate clue had been discovered for tracing particular strata, we have been able, not only to recognize them by their surface indications, but also to determine the exact place they occupy in the series. By pursuing the work on this plan, we shall, particularly on the completion of the survey, when a full description of our geology can be rendered clear, by reference to suitable maps and drawings, furnish to the practical explorer, many useful rules to guide him in his discoveries; while the chemical examinations, now in active progress, will have accumulated a vast body of valuable facts, showing the true composition, and thereby the exact economic value of our numerous minerals in all their important varieties.

To state more in detail the extent to which the survey has been pursued, in the various sections of the State, I shall, for the sake of convenience in description, adopt the division into districts, proposed in my former annual reports.

In the first district, embracing that portion of the State which lies south and east of the Kittatinny valley, the field researches consisted chiefly of a careful revision by myself, of some of the observations made by members of the corps during former seasons. Though I have now in my possession, full details illustrative of the structure and mineral wealth of this diversified region, yet there remain a few rather intricate neighborhoods to be examined before a systematic account of its geology can be safely published.

In pursuing the investigation in the second district, comprising the country between the South mountain and the Allegheny mountain, and between the Delaware and Susquehanna rivers, I had the valuable aid of Messrs. Charles B. Trego and Peter Lesley, Jr., whose previous researches in this and adjoining parts of the State, qualified them to assist in unfolding its intricate geology. Mr. Trego examined the Kittatinny valley, devoting the earlier portion of the season to the exploration of that part of it which ranges from the Delaware to the Susquehanna, comprehending most of Northampton, Lehigh, Berks, Lebanon, and Dauphin counties. In this belt of country, particular attention was bestowed upon that tract, so important for its iron ores, which skirts the southern side of the valley near the Lehigh river, and traverses Northampton and Lehigh. The recent establishment in that neighborhood, of extensive iron works for smelting the ore, by the aid of anthracite coal, has rendered the question of the quantity and quality of all the accessible ores of this belt, of not merely local but general interest. In this view of the subject, some of the veins of magnetic iron ore, belonging to the range of hills south of the Lehigh, investigated by Mr. Boye, with much care and success upon a former occasion, also received attention. Aware of the useful bearings upon both the iron and coal interests of eastern Pennsylvania, of every discovery which may cast any light upon the laws according to which nature has distributed the rich ores of this favored valley, every exertion was made to detect them by their surface signs, and to trace their relation to the neighboring strata, throughout the whole extent of the valley to the Susquehanna.

Apprized likewise of the growing demand for lime as a manure, particularly in the lower country, accessible to the Delaware division of the State canal, it was deemed advisable to examine and collect for analysis, the limestones of various extensive quarries, situated near the river below Easton, that their comparative adaptation to agricultural uses might be accurately estimated. Numerous specimens of hydraulic cement, found in many situations in the limestone belts of this region were also preserved for similar examination.

The latter portion of the season was spent by the same gentleman in the northern part of Dauphin, the southern part of Northumland, and the adjoining corners of Schuylkill and Columbia counties, in defining and tracing the strata which extend between and around the western points of the several anthracite coal basins, keeping in view the double object of detecting and identifying the mineral deposites of the region, and of collecting topographical details for a correct geological map. These observations were extended into some portions of the coal fields themselves, where much had been already accomplished towards a geological map of the several basins, and were made to include likewise, the region of Montour's ridge, where these features of the surface afford so important a general guide to the range and distribution of its invaluable beds of iron ore. Some examinations, preliminary to more thorough researches to be undertaken hereafter, were made among the coal beds and layers of iron ore at Wiconisco, Raush Gap and Shamokin, where data were collected with the view to show the number, thickness, and relative position of these deposites.

To Mr. Lesley was assigned the long, comparatively narrow belt of country, embraced between the southern base of the Kittatinny or Blue mountain on the south, and the range called the second, mahoning and Pokono mountain, on the north. In the exploration of this region, his attention was directed closely, and with much success, to the physical features of the region, as furnishing an important key to its geological structure. The several axes of elevation, their number, course, and relative positions to each other, were subjects of study, as casting light on the range and distribution of the upheaved formations. Assisted by this method of examination, the limits of each great stratum, or formation, were traced, and the requisite observa-

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and artificial exposures, and also, in part, from the number of abrupt axes of elevation which give to the beds various unexpected positions, and efface all bold and prominent marks upon the surface, by which we are accustomed, in other regions, to identify and follow particular deposits. These difficulties can only be surmounted by our causing the several beds of coal and other strata, to be exposed by a series of systematic diggings, made at various points judiciously selected, upon the plan adopted by us in the coal basins N. W. of the Allegheny mountain.

A general sketch of the topography of the Broad Top coal region, was given in my last annual report. The south-west portion alone, possessing any well marked features of the surface calculated in the absence of the mining operations recommended, to elucidate its geology, the investigations for the present were more particularly directed to this portion of the general basin. It is intersected by several deep transverse ravines, which divide the general table land into short ridges and insulated knobs. These ravines are watered by several considerable streams, the chief of which are Trout run, emptying into the Juniata, a short distance above Hopewell Furnace, and Six Mile run discharging itself into the same, two miles below. Between the latter stream, and a branch of the former, are the high rounded summits known as Round Knob and Blue Knob, and between the two branches of Trout run, lies the elevated point called Swartz's ridge. These are the only conspicuous features in the basin, which serve as a clue to its geological structure, for most of the table land of Broad Top, is a high irregularly undulating surface, deficient in those topographical outlines which mark the stratification. After various attempts to determine the number and course of the several anticlinal axes that traverse this region, a knowledge of which would prove the best guide by which to identify the mineral beds, the examination was abandoned as impracticable, until the funds of the survey would authorize, during another season, our employing a skilful miner to open the coal at numerous points where indications of it exist.

The coal seams at present developed, are at points far apart, while the exposures are too few and indistinct in the intervals, to justify any attempt at referring them to their relative positions in the series, or tracing them through their constantly changing dips into other parts of the basin. Thus, on Six Mile run, the thick coal seam, known as Riddle's vein, is opened a little more than a fourth of a mile from the river, but we do not meet with it again, until we recede from the river, about three miles and a half, where we recognize it at the mine of Messrs. Loy & Patterson, though the evidences from the dip of the rocks in the intervening tract, convince us that it must rise to the surface, in one or more localities between the two places mentioned. On Trout run, it has not been found within three miles and a half of the Furnace, though at this distance, it is mined by the Hopewell company. Notwithstanding this, there occur indications of coal, probably of the same seam, within one and a half or two miles of the furnace, up the run, but the only means of definitely identifying the coal, at these intermediate places of out-crop, is by calling in the aid of some practical miner, whose assistance we hope to have, when completing these researches another season.

That part of the third geological district, which is included between Tussey's mountain on the east, and the Allegheny mountain on the west, was examined with much diligence and skill by Dr. Jackson, who carried his researches from the neighborhood of Sarah Furnace, in Bedford county, where he had terminated his explorations the previous season, to the Maryland line. The formations lying at the base of the Allegheny mountain were first studied, and then the others in the descending order. Formation IX., at the foot of the Allegheny, was minutely examined in all the ravines, and other natural exposures, in the hope of finding that important belt of iron ore which follows the lower layers of this rock in a corresponding situation in Lycoming and Clinton counties. Though we had already ascertained that the ore was wanting in that part of the formation which crosses Centre and Huntingdon counties, there was a faint hope that it might reappear, as such beds often do, in Bedford, but the minute observations made, have failed in detecting any indications of its existence.

The calcareous and ferruginous beds, near the bottom of the next inferior stratum, F. VIII., so abundantly developed in some other sections of the State, were next carefully sought for, but the valuable iron ore, extensively distributed with this formation in Mifflin, Juniata, eastern parts of Huntingdon and Bedford, and in Franklin, could not be discovered, and the useful cement layers seen in Clinton and Lycoming were ascertained also to be absent. The only representative found of these beds is a dark slate, in the corresponding part of the formation.

The strata inferior in position to F. VIII., containing important minerals, received particular attention. The *fossiliferous iron ore* of F. V., now ascertained by us to range in so many belts through the Appalachian chain of the State, was carefully traced, in association with the stratum enclosing it, and found to extend the whole way to Maryland.

Besides these explorations, intended to bring to light the mineral wealth of the district, observations were systematically made, with a view to the construction of a correct geological map, and sections, by which to exhibit more plainly the true structure of the region, and the position, range, and distribution of its rocks, with their included minerals.

A large portion of the fourth district, or that which lies between the eastern base of the Allegheny mountain and the western foot of Chesnut ridge, and its prolongation to the N. N. E., and between the west branch of the Susquehanna and the Sinnemahoning on the N. E.; and the Maryland line on the south, was this year explored in detail; and, notwithstanding the wild character of many parts of its surface, with very considerable success. In this particularly arduous portion of the survey, I owe much to the zeal and untiring energy of Mr. James T. Hodge, whose familiarity with the methods of research requisite in a wooded country—acquired during former seasons, in some of our northern counties, and, previously to this, during two years in the wilderness of the State of Maine—qualified him with the species of skill particularly wanted in this department of the survey. Mr. Hodge was assisted by the persevering labors of Mr. Townsend Ward, throughout the whole campaign, which lasted more than seven months, and, by the efficient co-operation of Mr. Lesley, who joined the party upon the termination of his duties in the second district, in the month of July. Though a tolerably minute reconnaisance of several sections of this district, especially in Somerset and Cambria, had been already made in the summer of 1838, by Messrs. Trego and Ward, I found it indispensably necessary, to a full understanding of its structure and rich mineral resources, to carry on the exploration in a more methodic way, by the aid of a party of assistants and miners, provided with tents and other equipments essential to an uninterrupted residence in the woods. I therefore placed under the charge of Mr. Hodge and his associates, three skilful miners, whose business it was to expose, by judiciously conducted diggings, the outcrop of all beds of coal, limestone, iron ore, or other materials, either obscurely indicated on the surface, or merely inferred to exist by previous measurements of the adjoining rocks. By this combination of scientific research, with practical explorations, the true position of nearly every mineral band in the district has been established, and the number, thickness, quality, and distance asunder of the various beds, definitely ascertained in numerous localities, so as to afford a clue to the mineral resources of every important neighborhood in the several basins comprised within the region.

The operations of the season were commenced in the first narrow coal basin lying immediately N. W. of the Allegheny mountain in Centre county, resuming the investigation on the head waters of the Tangascootac and Beach creeks, where the close of the previous season had arrested it. This basin was explored south-westward into Cambria county. The second and parallel basin of the West Branch, was likewise carefully examined, commencing in the neighborhood of Hyner's run in Lycoming, and tracing it by Karthaus, to the head waters of Big and Little Clearfield creeks.

Explorations to be hereafter extended to the south-west, were next commenced in the third basin, on Bennett's branch of Sinnemahoning; after which a fourth basin, the next in order towards the N. W., lying near the sources of Little Toby creek, was likewise examined. Important discoveries of coal seams and beds of iron ore were effected, in the two last basins; those on Bennett's branch having already resulted advantageously to the proprietors in the neighborhood. The investigations of the season were next extended into the coal fields, which occupy the southern half of Cambria, the whole of Somerset, and the eastern townships of Westmoreland and Fayette. In this part of the district likewise, the field researches have resulted in the development of many important discoveries, not confined merely to the disclosure of beds of coal, iron ore, limestone, fire-clay, &c., in localities where they were previously unknown, but establishing conclusions respecting the range and distribution of these mineral beds, throughout the several basins which they occupy, calculated to be lastingly useful to the region. A revision of certain points, still somewhat in doubt, and an application of the same methods of research here applied, aided by the clue procured by this year's work, to the unexplored portions of the same basins, and to the great basin of the Monongahela and Allegheny rivers, during one remaining season, will, it is believed, make clearly known every bed of the least importance, belonging to any of the wide bituminous coal fields of the State.

The operations in the fifth district, which comprehends all that portion of the State lying west of Chesnut ridge, and the eastern boundary of Armstrong, Clarion and Venango counties, were, during the past year, confined principally to Erie, Crawford, Mercer and Butler, in the north-west, and to Greene county, in the south-west. The difficult task of making a systematic and detailed exploration of the obscure, but valuable coal field of Mercer, Crawford, and western Venango, was allotted to Mr. Harvey B. Holl, who, by bringing to the investigation much previous practice and skill, in minute research, succeeded beyond my hopes, in establishing a clue to the stratification of this portion of our western coal measures. Baffled during two previous seasons, in my efforts to ascertain the true order of superposition of all the lower coal measures as they appear in Crawford and Mercer, the success which has attended the past season's researches, to which those of former years greatly contributed however, is particularly gratifying. Though the closing in of the year arrested us in the work of identifying and tracing out all of the mineral beds of the series by the clue discovered, yet much was done towards unfolding accurately the position of the mineral treasures throughout Mercer, Crawford, the south-western corner of Venango, and the central tracts of Butler. And I confidently anticipate being able, with an adequate corps employed for one more year, to extend the exploration throughout all the adjoining counties, so as to place us in complete possession of the geology of the whole western district of the State. The key to the stratification which we have now secured, will enable us to open up whatever remains yet obscure in the resources of all those tracts, which have not yet been minutely traversed, and we shall apply ourselves during another season, under highly advantageous circumstances, to the exploration of the remaining portions of the counties mentioned, and also, to that of Warren, Venango, Clarion, Armstrong, Westmoreland, Fayette, besides portions of Greene, Washington, Allegheny and Beaver, parts of all of which yet remain to be examined.

Those sections of Greene and Washington counties, which have been unavoidably omitted during former years, were surveyed in considerable detail, in the three latter months of the past season, by Mr. M'Kinley and Doctor Jackson, who succeeded in establishing, with sufficient precision, the true order and thickness of all the strata overlying the Waynesburg coal seam, and in tracing their range and outcrop throughout the central and western portions of Greene, and the adjoining parts of Washington. Both of these counties, however, should receive some further examination before that precision can be imparted to the description of their resources, which the practical purposes of the survey, and the reputation of the State demand.

The business of compiling, chiefly from our own original observations, a series of new maps, embracing the more intricate topography of the mountainous districts of the State, has been diligently and steadily pursued during the past year. These maps are on a larger scale than the present map of the Commonwealth, many of the grosser errors of which they will rectify, while they will constitute an essential basis for the geological map, intended to elucidate my final report. Another year in the field, will suffice to complete all those observations intended to exhibit the more complicated portions of the geography and geology of the Appalachian chain. When published, they will prove an indispensable accompaniment to the detailed description of the mineral wealth of the State, besides embodying much that is new, towards an improved topographical map of Pennsylvania.

The draftsman of the corps, Mr. George Lehman, whose duty it has been to sketch from nature, the more striking points in the picturesque scenery of the State, and to delineate by his admirably faithful pencil, all those features of the surface, and the stratification which might assist in elucidating the descriptions hereafter to be given, of both the topography and geology, has executed his work of the last year with much ability and success.

Numerous specimens, comprising a large collection of ores, coals, limestones, cements and other minerals, designed for the State cabinet, have during the last year, been gathered in the various districts where explorations were conducted. These are now undergoing a careful classification, a portion of our winter's duty being to open and arrange them, that they may be as accessible as possible, for chemical analysis, and for consultation by myself and assistants, while writing our descriptions of the geology. My practice has been to classify them temporarily, as they have been collected from season to season, foreseeing much useless consumption of time, from any attempt towards a final arrangement of the cabinet, still incomplete in nearly all its parts, until the last season's gatherings shall have been added. Upon the termination of the field work, when the collection will have been rendered entire, the requisite analyses finished, and the final report written in reference to it, then I conceive, will be the time to place the whole at the seat of Government, so arranged, as to furnish in miniature as it were, a complete picture of the geology and mineral wealth of the State.

To put it at present in a position inaccessible to myself and my assistants, would be seriously to interfere with the chemical branch of the survey, to prevent the wished for precision in our mineralogical descriptions, and frustrate in fact, any supposed advantage to the public, by presenting it incomplete, and before the publication of the final report, which alone can render it of any value for reference.

In the laboratory of the survey, a very extensive series of chemical analyses, embracing all the varieties of our iron ores, coals, cements, limestones, &c., from many localities in the State, have been executed. These researches are conducted by Dr. Robert E. Rogers and Mr. Martin H. Boye, whose successful performance of their difficult and engrossing duties, has already redounded much to the usefulness of the survey. By these chemical labors, the exact composition of every mineral of any importance in the State will be ascertained, so as to place beyond doubt, the true value of each variety, and shew its adaptation to the arts and to agriculture.

Allotting the examination of the several divisions of the State, in the manner here mentioned, to the different members of the corps, my own time was spent to superintending either in regular rotation, or as the difficulties of the exploration demanded, the operations in each district successively. By this organization, each assistant can devote himself long enough to the study of a given district, to familiarize himself entirely with the local minutiæ of its geology, while the general supervision of the whole by myself, enables me, in cases of doubt and difficulty, to apply to their solution, both my own observations and those of the other members of the corps.

From the foregoing statement of the degree of forwardness to which the geological survey has been carried, it will be seen, that though extensive progress has been made in every district but the northern one, many important neighborhoods remain to be examined. Influenced by an earnest wish, to complete the work as expeditiously as is consistent with the exactness and minuteness in the results demanded by the law, I have so far matured the investigation, as to feel confident of being able to complete all the field researches in another year. The several acts of the Legislature, making appropriations for the survey, cease on the first of April next, five years from the commencement of the work, though they do not require that it shall be then finished. I have deemed it my duty, therefore, to present the above statement of the present condition, and future wants of the survey, that the Legislature may adopt such action as it may deem wise, concerning its completion.

CHAPTER I.

Geology of a portion of the First, or south-eastern district of the State, not hitherto described, embracing that part of the South Mountains, which lies between the Delaware and Schuylkill.

I propose offering in this place, a concise description of the geology and mineral resources of a part of the belt of hills, known in our State, as the South mountains, confining myself to that division of the chain included between the Delaware and Schuylkill rivers. These hills, though of comparatively humble elevation, constitute part of a great mountain system, which extends through New Jersey and New York, under the name of the Highlands; and through Maryland and Virginia under that of the Blue Ridge.

Entering Pennsylvania at the Delaware river, they occur as a broad tract of nearly parallel, but irregularly connected ridges, ranging in the direction of their length from the N. E. towards the S. W. and having an average breadth of from seven to nine miles, until we approach the Schuylkill. These ridges rarely possess a height of more than four hundred or five hundred feet above their adjoining or included valleys; though their bold undulating outlines and the rugged steepness of their slopes, clothed usually with forest, give to their scenery a prevaling mountain character. Inclosed among these hills, as in so many basins, lie several soft and fertile little valleys, the soil of which reposes on the limestone beds of our second Appalachian formation. The materials not only of the well defined ridges, but of the elevated portions of the tract generally, are either primary rocks, belonging to massive and thick bedded varieties of gneiss, or they consist of a white sandstone, the lowest in geological position of our older secondary strata. To the nature of these materials, and to the violence of the uplifting action, to which they have been subjected, we must ascribe the rugged and sterile character of these hills. Owing partly to the greater intensity, in the quarter next the Delaware of the subterranean disrupting forces, partly to the less thickness in this direction of the white sandstone, overlying the primary strata, these latter are here much more extensively developed than they are further westward towards the Schuylkill.

Before entering upon a more detailed account of the spaces occupied by the several formations, constituting the range of hills before us, let us trace the general boundaries of the whole belt and show how it is related in geographical and geological position to the other tracts which confine it on the N. W. and S. E. We shall then be prepared to delineate with precision the situation of the irregular, insulated patches of limestone, sandstone and other materials embraced among these hills.

Geographical range of the rocks of the South Mountains.

Tracing in the first place the south-eastern limit of the tract, we find it to coincide pretty accurately, along its whole extent from the Delaware to the Schuylkill, with the north-western margin of the red shale and sandstone rocks, which spread to the south, so extensively through Bucks and Montgomery counties, and which here overlap and conceal the group of rocks we are about to describe.

At the Delaware river, the boundary in question, passes close to the little village of Monroe, being more exactly marked by a small stream, which flows at the base of the primary hills. Taking a course somewhat west of south, the line runs about three quarters of a mile north of Bursonton; then crossing Durham creek, ranges west-ward to the vicinity of Opp's tavern, beyond which it bears to the north-west, approaching Leitz's tavern, about two miles south of Hellerstown. From this point, the line of division between the two classes of rocks, ranges in a direction a little south of west, until it meets the south branch of Saucon, about half a mile N. W. of Cooperstown. Here turning rather abruptly, and assuming a nearly south-western course to the head of Hosacock creek, which it pursues for some distance, it sweeps more to the west and passes out of Lehigh into Berks, crossing the line not far from the northern corner of Montgomery.

Entering Berks county, the line crosses the Sumneytown road, a short distance to the north-west of Ritz's inn; then taking a course about fifty degrees south of west, and nearly parallel with the Montgomery county line, it ranges north of the northernmost of the two meeting houses, in Hereford township; keeping a little south-east of Mount Pleasant iron mine, and crossing Swamp creek, about a mile above the county line. It next ranges through Boyerstown to Rhoad's mill, on Ironstone creek. Keeping south of the road to Kline's tavern, and curving at the same time westward, and then north-westward, it passes the Manatawny creek, a little below the line of Amity township. From this point the margin of the tract ranges north of west, to the intersection of the Limekill creek and the township road of Oley and Exeter. Here it turns again south-westward to follow a somewhat undulating line to the Schuylkill; crossing in its route Manokesy creek, a quarter of a mile south of Snyder's mill; then passing near a little church, crossing Raush creek, and finally curving round the base of the Neversink hill to the river.

Along the whole of the line just traced, the primary rocks, and the older secondary limestone, where this occurs, are overlaid unconformably by the edge of the middle secondary red sandstone. In several neighborhoods, however, the precise line of junction of the two sets of rocks is difficult to trace, owing to the quantity of soil, gravel, and fragmentary matter lodged near the base of the hills; this is the case, for example, between the south branch of the Saucon and the Hosacock. In other places, which will be alluded to hereafter in detail, the overlying rock is not the ordinary red shale and sandstone of the middle secondary series, but a coarse, variegated, and more or less calcareous conglomerate, identical in geological situation and in aspect with the rock commonly called Potomac marble.

The north-western boundary of the belt of hills before us, corresponding very nearly with the south-eastern edge of the great limestone formation of the Kittatinny valley, taken as a continuous line, begins at the Delaware river, about two miles below the town of Easton. From this point it is a somewhat undulating margin, stretching to the W. S. W., to within two miles of Maiden creek, a tributary of the Schuylkill, where it suddenly curves, to take a direction nearly due south to Reading. In the earlier part of its range, this line coincides almost exactly with the northern base of the Lehigh hills, maintaining thus, from the Delaware to Allentown, a course, parallel to the southern bank of the Lehigh, from which it nowhere far recedes. South-westward from the vicinity of Allentown, the edge of the limestone, bounding the tract, may be traced by Emaus, Millerstown, Metztown, and Walnut-town, to the curve near Maiden creek, already alluded to, where, sweeping south, it passes Solomon's temple, and takes thence the course of the road leading to Reading.

Though the line just traced, marks the general north-western boundary of the South mountains, there occur several small detached hills lying beyond it to the north-west. The longest and most elevated of these is Chesnut hill, near Easton. This, which is properly a spur of the general chain in New Jersey, consists chiefly of primary rocks. Another smaller ridge, consisting also of primary rocks, lies in a bend of Manokesy creek, about three miles north of Bethlehem. A third, still smaller elevation, occupies the bend of the Lehigh, immediately east of Allentown, pursuing for some distance the northern side of the river.

I shall now enter upon some details of the geology and mineralogy of the chain. Following the general plan of description observed in my previous reports, I shall trace each formation from the N. E. towards the S. W., describing the lowest or oldest formations first, and the others in the order of superposition.

At the north-eastern extremity of the tract, occurs Chesnut hill, the spur already alluded to. This, which is but the south-western prolongation of Marble mountain, a spur of the chain lying on the eastern or New Jersey side of the Delaware, starts at the river, and passing immediately to the north of the town of Easton, crosses the Bushkill above Hester's dam, and then subsiding into a long and narrow point, sinks under the limestone near Seip's, about four miles from its commencement. Its rocks, which are well exposed at the passage of the river round its eastern end, consist chiefly of gneiss, its southern flank alone containing other materials, the more interesting being a belt of talc schist, serpentine, and various associated minerals; the most interesting of these are zircon, actynolite, augite, silvery mica, soft wooly asbestos, and fine psuedomorphic crystals of serpentine. The gneiss belongs to the massive granitoid variety, so common throughout the whole chain. Its strata dip at a steep angle towards the S. S. E., but exhibit in many places much contortion, implying the violence of the forces which have uptilted them. The same dip is visible in the beds of the talc slate. The blue limestone of the valley F. II., encircles the base of this hill on every side, except just at the passage of the river.

Chesnut hill presents the mineralogist with several localities, from which beautiful specimens of various mineral species, especially of the magnesian class, may be obtained; a good collection of these was made by Dr. Swift of Easton. The northern part of the ridge, exposes on the river at "the Weygatt," high, overhanging cliffs of a rock of quartz and feldspar, containing veins of epidote. To the south of this, ranging along the southern slope of the hill, is seen a band of serpentine and other magnesian rocks, embedding a great variety of interesting minerals. Next the Delaware, the serpentine is mostly of the yellow sort, containing in places rhombic carbonate of lime, with indurated asbestos, and also, gray carbonate of lime in serpentine. Far up the southern slope of the hill, occurs a mass of semi-crystalline greenish grey augite, including fleshcolored carbonate of lime. Near the serpentine are several varieties of tremolite, some of it in bladed crystals, some greenish. A little to the westward, near Wolf's old quarry, the serpentine abounds with nephrite, some of which is of a beautiful bluish tint, some of a delicate pink hue, and containing small shining crystals of tremolite. A little south of the nephrite, indeed apparently intermixed with it, are several varieties of talc, as slaty, greenish, whitish, and a scaly green kind. Some of the talc is compact, and is mingled with serpentine, and pervaded with white fibrous carbonate of lime.

To the south of this locality, extends another band of coarse quartz and feldspar rock, in which some of the feldspar is reddish. This portion of it contains crystals of tourmaline and sphene. A belt of this rock occurs at the edge of the river, where it is overflowed at high water; it contains a quantity of soft asbestos, filling the joints. About one mile to the west of this point, being on the same southern slope of the hill, and a little west of the Easton and Wind Gap road, a beautiful silvery mica was formerly found in abundance, but is now nearly exhausted. Near this occurs a scaly talc, in which good crystals of zircon have been met with. Close to this spot, and near the spring that supplies the town with water, is found a white, tabular, crystalline tremolite, some of which is minutely dotted with specks of plumbago; a variety of greenish, tabular tremolite is also here. To the westward of this, in a little cleared meadow, were found specimens of a serpentine rock, containing flesh colored and light carbonate of lime; and also irregular masses of tourmaline in a crystalline serpentine. Here, near an old distillery, augite occurs in light green, earthy looking crystals, with well developed terminating faces. Still further westward, toward the gap of the Bushkill, and a little south of a syenite rock, which ranges through the ridge, we find a large band of tremolite rock, in the fragments of which are seen crystals of grey tourmaline. West of the Bushkill, on the eastern sloping face of the hill, we meet with a beautiful, dark green variety of serpentine, some of which has delicate streaks of white, probably carbonate of lime and asbestos. This band of rock is in solid beds, some of them several feet thick, and as it promises to prove susceptible of a fine polish, it may become valuable perhaps as an ornamental stone. It is obviously a *stratified* rock, overlying regularly the syenitic belt of the ridge, which here consists chiefly of sahlite, and dips S. S. E., towards the overlapping limestone of the valley. Between the solid beds of dark serpentine, lie thinner beds of a more slaty sort, with distinct bands of micaceous rock, dividing the serpentine and marking the plane or angle of stratification.

Though upon crossing these primary rocks to the northern side of the ridge, we find them near the Bushkill, in such close proximity to the limestone F. II., as to imply the absence of the generally interposed stratum, the white sandstone F. I., yet to the westward of this, a slate is seen, having the appearance of the slaty member of F. I., near which occur asbestoid and talcose slates, probably portions of the same lowest secondary rock. Higher up the hill, the blue limestone occurs in place, and adjoining it we find the gneiss. At the first of the above localities, the limestone in contact with the primary rocks, forms only a narrow tongue or point, running in from the westward, between the main ridge of Chesnut hill, and a smaller spur, which runs out to the Bushkill a little above the new stone mill. This smaller ridge consists chiefly of serpentine and talcose rocks, bounded at a short distance on the north, by the blue limestone. Some of the talc contains cubic crystals of sulphuret of iron, and some of it is interspersed with fine green serpentine, in which chrystals of zircon are said to have been found.

The true direction of the primary belt of Chesnut hill, is a little S. of W. Its more elevated portion terminates a little west of the Bushkill, beyond which the primary rocks are much concealed by diluvium, cropping out however at Seip's tavern. The high land represented on the Northampton county map, as the western prolongation of the ridge, is not strictly a part of it, but a line of limestone knobs occurring south of the true range.

Before proceeding to the main belt of the Lehigh hills, a small insulated ridge met with about three and a-half miles north of Bethlehem, claims attention. It commences a little west of the road leading from Bethlehem to Nazareth, and follows the south side of the Manokesy creek, in the form of a narrow eliptical hill, crossing the stream and terminating near the road which leads from Bethlehem to Mauch Chunk, a short distance west of which road its primary rocks sink away under the limestone of the valley. This ridge, formed of the same rocks as Chesnut hill, in the prolongation of which, moreover, it seems to lie, owes its elevation very probably to one and the same line of uplifting forces.

A third detached ridge, consisting chiefly of primary rocks, lies between Allentown and Bethlehem, immediately north of the Lehigh, and parallel with it. The principal rock in this hill, is a compound of quartz and feldspar, in which, however, are occasional seams of hornblende and epidote. Its northern side is strewed with fragments of yellowish white sandstone, F. I., the strata of which appear in place, dipping gently northward, at the eastern end of the hill, about a mile and a half west of Bethlehem.

The chain of the South mountains, consisting of nearly parallel, though often irregularly united ridges, will be best described by tracing each belt separately. The first group of ridges extends from the Delaware to Saucon creek, where a long, narrow valley, running in a transverse direction entirely across the tract, separates this from the other belts further to the south-west. Restricting our attention in the first place, to the group of hills east of the Saucon, they naturally divide themselves into three ranges; the northernmost, known as the Lehigh hills, commencing at the Delaware below Easton, and terminating near Hellerstown; the middle one, beginning also at the river above Rieglesville, and terminating north of Cooperstown, and the sou hernmost lying south of Durham creek, and running from the river to Springtown.

The first of these, the Lehigh hills, bounding for some miles the valley of the Lehigh river on the south, commencing in a loop of the Delaware, about two miles below Easton, ranges towards the S. S. W., and gradually approaches the Lehigh, until the primary rocks show themselves on the river bank, about a mile and a half below the mouth of Saucon creek. Near the east branch of this stream, the chain separates, enclosing small tracts of limestone between its spurs. The primary rocks occupy the margin of the river but for a short distance; the limestone, their usual boundary, resuming soon its place on the southern side. This belt of primary terminates near the bridge over Saucon creek, between Shinersville and Fremansburg, the limestone folding round the base of the hill, and extending up the east branch of Saucon. Between this east branch and the main creek, lie two other ridges or spurs, nearly in a line with the chain just mentioned, the southern one terminating east of Hellerstown, and the other further northward. Between them is a narrow limestone valley, which contrasts in breadth towards the east, and heads near the little or east Saucon. Though a separate chain of elevated rocks, the northern belt here described, is not entirely detached from the middle range already referred to, a tract of primary rocks lying round the head of the little Saucon, serving to connect them geologically.

In the general prolongation of the chain, but disconnected from the previous set of ridges, by the transverse valley of the Saucon and its south branch, we have the primary rocks extending towards the S. W., through the lower townships of Lehigh and Berks, in a series of nearly parallel spurs, almost to the Schuylkill. In describing the general south-eastern and north-western boundaries of the whole chain through Lehigh, we have already given very nearly the true limits of the primary rocks in that county. This part of the belt is separated longitudinally for several miles, into two parallel sets of ridges, by the upper part of the valley of the Saucon. One of these tracts, lying west and north of that creek, commences at the Lehigh, near Bethlehem, and ranging south of Allentown, and past Emaus and Millerstown, passes into Berks, losing there its character as a distinct zone of hills; the other originating west of the south branch of Saucon, ranges south-westward to the head waters of Perkiomen creek, where it merges westward into the general belt. On both sides of the county line, dividing Lehigh and Berks, the primary hills compose an unbroken tract, having a breadth of about six miles.—Passing still further to the westward, the general chain expands in width, but becomes subdivided by valleys entering it from the south and west; the broad primary tract, being broken into about five spurs or ranges, and the intervals between them, occupied by belts of limestone and sandstone, the latter often forming hills as elevated as those of the gneiss. The northernmost subdivision of the primary, starting from the general belt, in Rockland township, terminates about three miles east of the mouth of Maiden creek, near the head of Dry run. It is bounded on the N. W. by a narrow undulating strip of sandstone, F. I., which, from the neighborhood of Metztown, to Solomon's temple, separates the primary from the limestone of the Kittatinny valley. This tract of the gneiss is bordered on the south by a long, narrow tongue of the same sandstone, starting off from the main mass of that formation, east of Solomon's temple, and running eastward, past Pricetown, as far as Shiffert's Inn. West of Penn's mountain, which consists of the sandstone, and south of the Pricetown range of the same rock, lies another nearly detached tract of the primary rock, bounded on the E. and S. E. in Oley and Exeter townships, by the slates of F. I., and the limestone F. II. The margin of this large patch of primary strata, is made so excessively irregular, by the protrusion into it of the spurs of F. I., as to render it impossible to describe it intelligibly, without the assistance of a geological map. A third spur of the general primary chain, occupies the southern half of Rockland township, between the two head streams of Manatawny creek. A fourth, smaller spur, projects to the S. W., forming the northern corner of Pike township. It is bounded by Pine creek on the N. W. and by another parallel stream, also a tributary of the Manatawny, on the S. E. A fifth, and much larger tract of the primary rocks, fills the south-eastern part of Pike, the north-western two-thirds of Colebrookdale, and the northern half of Earl townships. It is limited on the N. W. and W., by a long narrow curving belt of the sandstone F. I., which follows the eastern side of the tributary just mentioned, and then the main creek. Its eastern border passes through Colebrookdale township, from Perkiomen to Ironstone creeks, making here a gently undulating line nearly parallel with the Montgomery county line. This south-eastern edge of the primary is formed by the margin of the overlapping red sandstone of the middle secondary period, except at a few points, where small patches of the limestone and white sandstone intervene. Between the head of Ironstone creek and the main Manatawny, near Spang's, furnace, there extends a small ridge of the lower secondary white sandstone F. I., which separates the primary tract along its southern limit into two divisions. A line drawn from a point on Ironstone creek, about a mile S. W. of Boyerstown, westward to the end of this sandstone ridge, will mark, with tolerable accuracy, the general limit of the primary on the south.

Of the included belts of Limestone.—The delineation of the several narrow belts of limestone, included between the primary ridges, and spurs of this portion of the general chain, will assist us in exhibiting the topography of this rather confused district. Commencing on the north, we have the limestone of the Lehigh, a part of the great formation of the Kittatinny valley, the margin of which we have already traced. Passing down the Delaware, from the mouth of the Lehigh, this tract of the limestone, measured obliquely in the direction of the river, has a breadth of about two miles, showing first a southern dip of about forty-five degrees, which diminishes, then passes into horizontal, and then into a gentle northern dip, showing a synclinal basin. Between the northern dip last mentioned, and the uplifted primary to the south, there are indications of a narrow anticlinal elevation of the limestone, connected probably with a high narrow ridge of the primary which appears on the Jersey Shore. Passing round the end of the first ridge on the Pennsylvania side, consisting chiefly of gneiss and syenitic rocks, we come to a narrow belt of limestone which extends westward from the river, about two miles, occupying a little recess between two spurs of the primary chain. This limestone is quarried near the river, at Ihrie's and at Harman's. A considerable quantity of lime is made at the latter place, which is four miles below Easton, and some of the stone goes down the canal to various points in Bucks county, where large quantities of it are used. Much jaspary chert, with chalcedony and quartz, derived from the limestone, strews the fields about a mile from the river, on Bruch's farm, (late property of J. M. Porter.)

The prevailing dip of the primary strata in the Lehigh hill, is to the S. S. E. at a steep inclination. Between these primary strata and the northern belt of limestone, we find indications, near the Delaware, of the presence of the white sandstone beds of F. I. This formation, if really present as a continuous stratum, must be of inconsiderable thickness. Resting as it does, directly on the violently uplifted primary rocks, its unfrequent appearance at the base of the hills may however be explained in part by the crush it has undergone, and by the mass of transported fragments concealing it from the sight.

The southernmost of the two spurs of the Lehigh hill, mentioned above as bounding the little narrow tract of limestone, forms the northern limit of another larger limestone valley, the southern boundary of which is Frey's run. The limestone of this valley dividing the northern belt of primary rocks from the middle one, heads on Frey's run, about two miles west of the Delaware, the last exposure of the rock being at Stout's quarry, where its dip is northward. The breadth of this tract, measured along the river, is very nearly two miles; here at Uhler's, about five miles below Easton, it is extensively quarried and converted into lime. The strata, which have been tilted into a nearly vertical position, differ much in the quality of the rock in the different layers.

Bounding this limestone valley on the south, we have the broad belt of primary rocks, which I have designated as the middle ridge of the whole mountain chain. The rocks of this range, comprising chiefly massive strata of gneiss and beds of syenite, cross the Delaware into New Jersey, forming a ripple called Rocky Falls. South of this middle primary hill, and north of the sourthern or Durham ridge, which is a prolongation of the Musconetcong mountain of New Jersey, there lies another narrow but rather longer tract of the limestone, occupying the valley of Durham creek. The breadth of this tract of limestone, measured along the river from a point opposite the mouth of Musconetcong creek to the mouth of Durham creek, is about one mile; the upper edge of the limestone, north of the village of Riegelsville, being much obscured by a covering of diluvium, and the lower bordered by the creek, along which it is well exposed, from its mouth to the neighborhood of Springtown. A little west of the old Philadelphia road, and north of that to Springtown, the limestone appears on the south side of the creek, dipping 60° nearly S. The dip is also southern in several places east of Springtown. The existence of a steep southern dip along the south side of this valley, is in strict analogy with the position of the rocks generally in the valleys of the whole south mountain chain, and implies an overtilting of the strata to the north. This *folding* of the beds upon themselves in the synclinal axes of our first great mountain chain, though highly curious, is a prevailing feature from Vermont to Tennessee.

East of Springtown there is a low ledge of sandstone, F. I., lying north of the road, and following the course of the creek in a northeastern direction.

South of the Durham ridge of primary, there occurs another smaller strip of the limestone, bounded on the south by the conglomerate and red sandstone of the middle secondary formation. This small tract shows itself a little west of the river, near Monroe, occupying the south side of a little stream. It is well seen in the quarry of John

Ermst, inclining 75° to a point a little E. of S., and in that of Johannes Kohl, where it dips to the S. E., at an angle of 30°. Its last exposure on the west, is at the old Philadelphia road, where the red sandstone overlaps it.

The next detached tract of limestone which claims description, is that of the Little Saucon, along the valley of which it may be traced, though with rather obscure exposures. The rock shows itself in the creek about half a mile north of Lower Saucon church, near a blacksmith's shop. Further up the creek, it is said to have been dug, but found too slaty for use. Its last occurrence along the stream, is on the premises of John Rinke, near the intersection of the road and the creek, where it is well exposed, and of a good quality. At this place, its strata dip 40° north-westwardly. Ascending the creek beyond this, the primary rocks show themselves, and the country becomes wild and rocky.

The next tract of limestone is that of the main Saucon creek, in the valley of which, it is the prevailing rock, from within a mile of the Lehigh, almost to the very source of the stream. This belt of the secondary rocks, ranging in a N. E. and S. W. direction across the primary tract, separates the group of ridges terminating on the Delaware from the rest of the chain, stretching towards the Schuylkill. Conforming to the general curvature of the valley of the Saucon, the limestone occupies, throughout the greater part of its course, both sides of the creek, and ascends, for a little distance, some of its tributaries. The lowest point at which it shows itself, is about a mile and a half north of Hellerstown, and by the channel of the creek, nearly two miles above its mouth. Expanding soon in breadth to embrace both channels of the Saucon, which here divide to form an island, one part of the tract sweeps eastward, running up between two spurs of the primary, until it terminates in a point about two miles east of Hellerstown. Half a mile east of the town, the limestone is seen dipping to the N. W. A little to the east of this, between two small hills of gneiss, a short belt of the sandstone F. I. appears, the rock resting directly on the primary, and dipping towards the W. N. W. Beginning with the termination of the limestone, east of Hellerstown, the southern edge of the formation will be found running from hence, in a general south-western course, along the southern side of the valley of the Saucon. About the Lehigh county line, a spur of the primary, running down between the main creek and a small southern tributary, insulates the limestone in the valley of the latter, in the form of a little cove, where it is opened in two quarries, belonging to Abel and Flexer. The general margin of the formation follows the northern foot of this spur as far west as the south branch of Saucon, where it doubles round it; the limestone here running eastward to form another little cove between the spur already mentioned and a second small belt of primary to the south of it. The north-western point of the spur includes a small tract of the sandstone F. I. The edge of the limestone now crosses over to the western side of the south branch of Saucon, extends in that direction about half a mile, and then curves back by the south and east until it again meets the stream, where the limestone disappears beneath the overlapping middle secondary rocks. Within the curved edge just traced, is included, therefore, a third small cove of the limestone, lying like the others, between two jutting points of the primary. Coming back now to the general southern margin of the limestone, we trace it from the south branch of Saucon, first westward and then south-westward, along the main creek nearly to its source, about a mile and a half N. E. of Shimer's. From this point, the whole way down the northern side of the valley of the Saucon, the other, or north-western margin of the limestone nowhere departs far from the border of the stream, following the curvatures in its course, with considerable regularity, to the point where we commenced our description, about a mile south of the Lehigh. The limestone of the main belt of the Saucon is quarried east of Hellerstown, as already mentioned; also at a point about half a mile south of it, dipping at both of these places towards the N. W. It is opened also at Upper Saucon church, in a quarry belonging to Jacob Cornell, on both sides of the road, where the dip is towards the south. South of the creek, about half a mile from the intersection of the Allentown road with that leading south from Upper Saucon church, occurs Toger's quarry, where the rock dips to the south, as it does at a point north of this, near the creek. Crossing the creek on the road to Allentown, we find another quarry, the strata dipping to the S. S. E.; and another about two miles higher up the stream, at Peter Egner's, a little west of the road which leads eastward from Emaus. Here the dip is gentle, and a little N. of E. Still farther up the creek, beyond the Upper Saucon township line, there is a large quarry, owned by several persons. The prevailing dip just here is to the N. E. The last exposure of the limestone is about a mile and a half above this, in a quarry belonging to John Otto and Laurence Stahler. The dip is gentle, and to the S. W.

Upon the south branch of Saucon, the limestone is opened at Peter Moyer's quarry, and at John Beringer's mill, where the limestone, on this tributary, rests in contact with the overlapping red shale and sandstone, it loses its usual clear blue and acquires a light, bluish pink color. In this vicinity the rock is highly magnesian, and would no doubt, be well suited for making a hydraulic cement. The rock exhibits a crushed character, consisting of innumerable small square fragments.

Besides the continuous belts of limestone now traced, there occur, in the region of these hills, several small isolated patches, remnants as it were, of a once widely diffused tract of the formation, the main body of which has been broken up and swept away. Commencing with the easternmost, we meet with one of these at the Bucks county line, at a point about a mile and a half west of Springtown; and about a mile further westward another, where the rock has a dip of 35° to the S. E. and is quarried by Mr. Leitz. These two patches lie embraced in the primary. In Upper Saucon township, south of the creek, and a little west of the Allentown road, we meet with a third, near the top of a primary ridge, where the rock is exposed at Erdman's quarry. The limestone is of the common blue variety, but it abounds in fissures filled with white carbonate of lime. Its proximity to the agricultural district south of it, where no limestone occurs, and its elevated position which facilitates hauling, cause it to be somewhat resorted to. The rock quarried, is sold on the spot at 2¾ cents per bushel, and the lime at 12½ cents. The only other detached localities of the limestone, in Lehigh county, occur in Upper Milford township. One of these is at Daniel Walder's quarry, about one mile S. W. of the uppermost exposure of the limestone on the Saucon. It is near the source of one of the main branches of Perkiomen creek. Another lies in the western corner of the township, half a mile S. W. of Hampton furnace, being also on a tributary of the Perkiomen; and a third, is on the Hosacock creek, on the premises of Abraham Gerrard. The rock here, is in close proximity to the middle secondary red shale and sandstone.

There remains one other tract of the limestone to be spoken of as occurring south of the Lehigh, occupying a recess in the primary belt immediately south of Bethlehem. Commencing on the southern bank of the river, about a mile above the town, the margin which divides it from the primary, runs in a crescent, until it meets the river again some distance below the town. Thus enclosed, it forms properly but a part of the great belt of the Kittatinny valley.

Durham Cave.

Before quitting our description of the limestone, we may devote a few words to a cavern which occurs in this rock on Durham creek. Its position is a little north of the stream and not far from the Delaware. It has a length of about three hundred feet, an average height of twelve, and a breadth varying from four to forty feet. The floor of the cave is not level, but descends as we penetrate to the interior. Its rough walls are covered with few pendants or stalactites. Much of the bottom of this cave is covered with water, the level of which is influenced, it is said, by that of the Delaware. About half way down occurs a narrow lateral cavern, terminating in the form of the letter T. The general direction of the main gallery is S. W. becoming S. towards the remoter end. The rocks show an anticlinal axis about twenty yards S. E. of the entrance of the cave, the direction of the axis and the cave nearly coinciding.

Most of the limestone of the several tracts above described, belongs to the blue varieties of this rock, so familiarly known. It is by no means, however, invariable in its composition, very many bands being more or less magnesian and some so highly so, as to furnish, when properly treated, an excellent hydraulic cement. Occasionally we meet with a somewhat rare and interesting variety, possessing an oolitic structure.* Bands of this are met with above South Easton, and also on the Bushkill, near Wood's coopershop, and again at Squire Kemerer's limekiln, north of Chesnut hill. These oolite beds of F. II. are not unfrequent in other counties of the State; their common position seems to be near the bottom of the formation.

Localities of the Sandstone F. I.

That the white and grey sandstone F. I., the lowest of our secondary rocks, is not a continuous stratum in the belt of the South mountains, where they traverse Northampton and Lehigh, is rendered highly probable by the unfrequent and local manner in which it shows itself. Still we are entitled to consider it as not confined merely to the few scattered points, where it emerges to the day, but as resting in many places at the base of the primary ridges, buried under a deep covering of loose diluvium. We have already referred to various places where it crops to the surface in sketching the limits of the limestone, which, whenever it is present, it immediately underlies. With the exception of a single doubtful locality, it nowhere shows itself near the Delaware, for there are many exposures in this part of the chain where the limestone is seen resting directly in contact with the primary. Going westward, it first shows itself in the localities already referred to on Durham creek, a little east of Springtown, in the ridge bounding the limestone east of Hellerstown, and in the end of the spur immediately east of the south branch of the Saucon. Ascending the Lehigh, the first point where it appears in place, is on the south side of the river about a mile south of the Bethlehem bridge, where it occurs in a thin band, resting on the primary, and dipping northward 20°. It runs in a narrow belt from the road eastward to the Saucon, where it adjoins the lower termination of the limestone of that stream. We have already mentioned the occurrence of the formation on the northern slope of the small ridge of primary rocks occupying the north side of the Lehigh, east of Allentown. It shows itself again not far from this, on the southern side of the river, about a mile below the Allentown bridge, the piers of which have been constructed of it. Here it constitutes but a thin stratum, the limestone in some places lying nearly in contact with the primary. There are but two other localities in Lehigh and Northampton counties. The first of these is near the top of the mountain east of Emaus, where a rather coarse variety of the sandstone is seen dipping with the slope of the mountain, rather steeply towards the W. N. W. The mountain itself is gneiss. The other locality, at Millarstown, exhibits the sandstone as a low ledge at the foot of the mountain, dipping 10° towards a point 75° W. of N. Westward of this, especially in Berks, it increases in thickness and abundance as we approach the Schuylkill.

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* Oolite.—A limestone so named because it is composed of rounded particles, like the roe or eggs of a fish.

Sandstone and Limestone, F. I. and F. II., in Berks county.

The white sandstone which appears in a few detached localities along the north-western line of the South mountains in Lehigh county, begins to show itself as a more continuous formation, after we enter Berks, rising even into high irregular ridges in the south-western part of the chain. A very usual position of the sandstone is upon the flanks and around the extremities of the primary spurs, where it often indeed overtops the gneiss and igneous rocks, which then appear only on the crests of the hills, as low dykes, difficult to trace. Even where the sandstone is best developed, some difficulty attends our tracing it as a continuous formation. This arises from its immediate proximity to the greatly convulsed primary strata, and from its lying so frequently on the declivities of the hills, where its outcrop is much obscured by fallen fragments. The sandstone, where it is subordinate to a larger ridge of primary, often either encircles, at a little distance, the extremity of the spur, lies more or less obliquely across it. Sometimes, even in the middle of a high tract of the sandstone, where no regular belt of primary rock protrudes itself, evidence is perceived of its having reached the surface at certain spots, from the quantity of angular fragments. The sandstone itself offers often great difficulty, in determining its stratification and the true direction of its dip; whole hills looking like mere piles of huge angular blocks, or innumerable fissures and cleavage-joints, traversing the beds, so as greatly to perplex the observer.

Metztown.

Passing from Lehigh into Berks, the first exposure of the sandstone, is at a hill, lying south of the Little Lehigh, and about two miles S. E. of Metztown. Here the rock is chiefly in loose pieces, covering the foot and lower acclivity of the hill. The sandstone also shows itself in place, about one mile south of Metztown, immediately west of the church. Between the visible edge of the limestone, which passes by Metztown and the foot of the primary hills further south, there is a considerable tract of country where no rock appears upon the surface, with the exception of the isolated tract of sandstone, at the church, just referred to; a deep covering of diluvium hiding every thing from view. Approaching the mountains from the north, the first rock seen in place, is a white variety of gneiss. This is on the road leading to Hoof's inn. West of this, in Maxatawny township, the limestone is seen where a road crosses the Sacony creek. The sandstone, which shows itself N. E. of the creek, disappears a little south of Grim's mill, the gneiss showing itself on the west side of the stream, between the mill and Hunter's furnace.

The general margin of the limestone, passes about a quarter of a mile north of Walnut-town. About a mile south of this place, on the N. E. of the road, occurs a sandstone ridge, running in a N. E. direction. A littler further south, upon the same road, we observe the outcropping of the gneiss. This gneiss, part of a long belt of primary, averaging about a mile in breadth, terminates at Millar's mill on Dry run. A belt of the sandstone, as already described, flanks it both upon the north and south, the sandstone uniting round the point of the primary, a little east of Solomon's temple. Southward from this last mentioned place towards Reading, the sandstone lies on the east of the road, the whole way to within three miles of the town, where a belt of slate, probably the upper member of F. I., crosses the road. If we here turn aside to the N. E., taking the road to Barnard's mill, (Rothermel's mill on the county map,) we encounter, just at the mill, a low protruded mass of igneous rocks. A little to the N. W. of this point, a small body of limestone has been discovered, south of which, in the sandstone, we may trace a low dyke of syenitic rocks running towards the N. E. East of its north-eastern end, and west of its south-western, occur two other small patches of limestone. The line dividing the limestone of the Schuylkill valley, from the sandstone and slate bounding it on the east, after following the road which leads from Solomon's temple south, suddenly curves to the eastward about two miles north of Reading, reaching, but not crossing, the road from that borough to Princeton. Here, at Rothenberger's inn, turning very abruptly to the S. W., and gradually receding westward from the road last mentioned, it next runs to the Schuylkill, passing through the western side of Reading, leaving thus a triangular tract of the limestone protruded into the general area of the sandstone.

Hills East of Reading.

Penn's mountain, commencing east of Reading, and running in a N. N. E. direction nearly five miles, consists, on its summit and western side, of the white sandstone, F. I., dipping to the W. N. W. Descending the eastern slope of the mountain, we soon encounter the primary rocks, which maintain this position as far to the S. W. as Kesler's mineral spring. This is the termination of a wide belt of primary rocks, chiefly gneiss and syenite, coming off from the general chain to the N. E. with a prevailing S. W. and N. E. direction of the strata. At Spie's church, there occurs a high sandstone ridge in the midst of the primary, being detached from any other tract. Penn's mountain, at its northern extremity, sweeps suddenly to the eastward, jutting between the main belt of the primary around Spie's church, and a narrower tract which crosses the Reading and Pricetown road. North of this last piece of primary, and N. W. of the prolongation of Penn's mountain, are some high sandstone ridges, probably concealing dykes or beds of primary rocks between them. Pursuing the road north-eastward to Millar's inn, we have the sandstone on the N. W., while on the S. E., the hills consist principally of gneiss. Between Millar's inn and Pricetown, the road separates a hill of gneiss on the S. E. from a high short ridge of sandstone on the N. W. Gneiss occurs also about one mile from Pricetown, S. E. of the road going towards Sterner's inn, (of the map.) A sandstone ridge rises at Sterner's inn, on the N. W. side of the road, and extends nearly to the tributary of Manatawny creek, in Rockland township, beyond which, until we pass Roth's mill, all the rocks are primary. Going E. of S. from Roth's mill to Pine creek, we encounter none but primary rocks forming a wide tract. The sandstone, however, shows itself at the spot marked Shiffert's inn, on the county map, appearing *in situ* on the slope of the hill, N. of the road. The rock here is somewhat coarse and of a purplish color. Passing to the S. W. it seems to cross the road.—Descending the creek we meet another ridge of similar sandstone, occupying the W. side of the stream, at a mill designated on the map as Mineder's. Further south, about a quarter of a mile north of Snyder's upper forge, (Udree's forge of the map,) the sandstone again shows itself on a small hill, east of the creek, and again on its western side.

The hill immediately to the S. E. of Sterner's Inn, consists obviously of primary rocks, the surface being wholly covered with their fragments, though no regular outcrop is seen. Still pursuing the road to Oley furnace, we pass diluvium, containing much fragmentary sandstone, until at the creek, close to the furnace, we behold the sandstone in place, dipping steeply on the east side of the stream, to the N. N. W. The rock here is coarse and reddish, and occasionally very talcose. Immediately west of the creek, lies a large hill of syenite, and about half a mile nearer Fredensburg, we come upon the margin of a wide tract of slate, apparently the upper member of our lowest secondary formation, of which the sandstone, hitherto most commonly encountered, is the lower. Nearly two miles N. W. from Fredensburg, on the N. E. side of the road to

Millar's inn, occurs a belt of sandstone, dipping steeply to the N. N. W. Here is an old mine of iron ore to be described hereafter. Beyond this, a sandstone ridge is seen running parallel with the road, about a quarter of a mile on its N. E. side. Between this and Millar's inn, an interval of about a mile, the prevailing rock is gniess.

Let us now trace the line which divides the gneiss from the slate and sandstone F. I., and the limestone F. II., in the northern and western parts of Oley township. About three-fourths of a mile S. W. of Lobach's mill, on Pine creek, we come upon the margin of the limestone, crossing the stream in an E. and W. direction, through the lands of Jacob Keim. The dip here is due S. 60.° To the N. E., and E. of this, the sandstone shews itself in a belt to be presently described. North of S. Peters' mill, (marked Maul's on the map,) runs the edge of the primary, which here exhibits no sandstone interposed between it and the limestone. The margin of the limestone is well seen half a mile W. S. W. of the mill, the rock dipping steeply to the S. S. E. Immediately above this limestone, on the creek, we have the slate crossing the stream just at the road leading to Sterner's inn. The true dip of this last rock is difficult to discover, owing to the obscurity of the divisional lines of the strata, and the abundance of cleavage planes, wholly independant of those which ought to mark the dip, the dubious direction of which leads to some uncertainty respecting the precise formation to which the stratum belongs. Could its beds be seen passing unequivocally under those of the limestone, it would plainly prove itself to be the upper, slaty portion of F. I; if, on the other hand, it should be seen to dip away from the limestone, at the line of contact, no doubt would remain as to its being part of F. III. The margin separating the slate from the gneiss, passes about half a mile N. W. of Fredensburg. Taking the road leading out of Fredensburg, to the S. W., we pass over the slate for nearly a mile and a half, until we cross a little stream, the dividing line of Alsace and Oley townships, where we pass directly upon the gneiss. Ascending the creek by a steep ravine, we pass the eastern termination of the spur of sandstone at Spie's church, already spoken of. East of this spot, the boundary of the slate and gneiss is near Knabb's mill, (Reiff's on the map.) The hills immediately west of the mill, marked Knabb's on the map, and of the road separating Oley and Exeter townships, are strewed with fragments of primary rocks, as far down the creek as the first exposure of the limestone, which is half a mile N. of the road running westward from Oley forge. Following this road, which deflects towards the S. W., we pass across a corner of the limestone tract, and at a short distance west of the Manokesy creek, encounter the common margin of the limestone and the primary. These two formmations rest apparently in contact, from the upper point of the limestone, on the Manokesy, below the mill marked Knabb's, throughout a mile and a half towards the S. W. About two miles east of Maurer's inn, the sandstone shows itself in place, between the limestone and the gneiss, on the southern slope of a hill, some distance north of the church. Under this sandstone, is an argillaceous slate, in very thin lamina. Between this and Maurer's inn, the rock is exclusively sandstone, the large double hill N. E. of the tavern, being entirely of this formation. Here a quarry has been established for getting building stone; the dip of the rock is obscure. This ridge of sandstone extends in a north-easterly direction, about two miles and a half towards the insulated sandstone hill, near Spie's church, from which, however, it is separated by more than a mile of primary country. East of the ridge, the rocks are a white variety of gneiss, consisting of quartz and decomposing feldspar, and a syenite composed of feldspar and hornblende, in frequent alternation with the gneiss. Where these rocks abound, the surface is marked by small rounded hills, covered with fertile soil, giving a pleasing aspect to the country. A similar topography is particularly striking in some parts of Colebrookdale township, hereafter to be mentioned. The limestone belt, bounded as we have already said, for the first mile and a half by gneiss, runs afterwards the whole way to the Schuylkill, below Reading, crossing Bishop's creek, about a mile below Maurer's inn, and folding round the southern point of the Neversink hill. From the Manokesy, westward to the Schuylkill, the limestone belt, bordered on the south by the middle secondary rocks, contracts into a narrow zone, a few hundred yards in breadth. On its narrow limit, it dips to the south. Where it crosses the Perkiomen turnpike, three miles from Reading, it shows in a quarry near the road, many beds, of a crystalline, granular structure. Much of the rock at this place is of a dull yellowish white. It dips a little W. of S. It strikes the western reach of the Schuylkill, about a mile and three-fourths south of Reading, where it is overlapped on the south, by the coarse calcareous conglomerate of the middle secondary series. North-eastward, this narrow belt opens into the wide tract of limestone, which occupies much of the eastern half of Oley township. From its southern point on Manatawny creek, a fourth of a mile below the line dividing Amity from Earl townships, the eastern edge of this large tract passes up the Manatawny, and then up its eastern tributary, as high as the line which separates Oley from Pike. Its northern margin crosses Pine creek, about a mile below Lobach's mill. Its north-western corner is at the place marked on the map, Peters's red ochre mine. Its western limit is the eastern boundary of the slate, which occupies a large tract in the western half of Oley. The limit between these rocks runs southward, nearly through the middle of the township, until it strikes the Exeter line a little east of Manokesy creek.

The slate, which we have already mentioned to be most probably the upper member of F. I., spreading from the western edge of the township, (Oley,) eastward beyond Kemp's inn, shows generally a dip to the S. S. E. About a half a mile south of Kemp's tavern, the slate is bordered by slaty limestone, which apparently overlies it. The slate, east of Fredensburg, graduates into slaty sandstone; but south of Rieff's mill, the slate is soft and sectile, approaching in texture to pipe clay. At this and several other places, its strata are intersected by veins of quartz.

I have already referred to the belt of sandstone which occupies the valley of Pine creek. This extends from the neighborhood of Pott's forge, to the edge of the limestone, a mile below Lobach's mill, where, doubling round the point of a wide spur of the primary, it runs eastward, to join the much longer tract of sandstone which follows the Manatawny and its eastern tributary, in Pike township, for many miles. This latter range of the sandstone, commencing near the western corner of Hereford township, crosses the narrow part of District township, and then the whole of Pike, following the eastern side of the Manatawny, nearly as far down as the line dividing Amity and Earl.

Mention has already been made of another tract of sandstone in the form of a ridge or spur, commencing about a mile east of Spang's furnace, and running in a N. E. direction, into the region occupied by the gneiss. At Hill's inn, the limestone is found on the east side of the Manatawny, dipping to the N. W. The sandstone immediately east of this, dips steeply in the same direction. A little north of the Amity township line, the sandstone on the other hand, crosses to the west side of the creek. At the bridge, on the township road, over the Manatawny creek, the limestone, in its upper beds, is striped by reddish ribands. A calcareous slaty sandstone here occurs, precisely similar in appearance to the red sandstone of the middle secondary rocks, of which it may be a detached or outlying patch. About a quarter of a mile below this, on the creek, is the general margin of the middle secondary red shale and calcareous conglomerate.

The southern half of Earl township includes chiefly long hills of syenite and other primary rocks, running in a N. N. E. and S. S. W. direction, having coarse sandstone, F. I., flanking them on their N. W. slopes. Taking the road from Kline's tavern, near the Manatawny, eastward to Boyerstown, the sandstone of one of these spurs, approaching from the N. E., shows itself on the road, dipping 35° S. S. E. At the intersection of the road and the township line of Earl and Douglass, we enter on the margin of a small tract of limestone, overlapped further south by the red sandstone. It crosses to the north of this road. The limestone peeps out at a house laid down on the county map, as Keely's tavern, and shows itself again in a quarry a few hundred yards east of the tavern kept by Mr. Gresh. Near Keely's old stand, the sandstone occurs on the north side of the road, and it again appears N. W. of Gresh's. The limestone to the south of this is overlapped by the middle secondary rocks. East of the limestone, and before reaching Rhoad's mill, we come, in succession, upon white gneiss, syenite, sandstone, and limestone, the latter appearing at the mill. From this point eastward, to Boyerstown, the whole space is occupied by primary rocks, covered on their southern margin, by the middle secondary.

All that part of Colebrookdale township, lying to the N. W., N. and N. E. of Boyerstown, consists exclusively of primary rocks. These form innumerable hills, covered by a deep and rather fertile soil, the whole district presenting, in a succession of undulating outlines, a highly pleasing series of landscapes. The limit of the primary and overlapping middle secondary sandstone, passing through this township, from Rhoads' to the west branch of Perkiomen creek, we have already defined.

A locality of crystalline limestone occurs in the centre of Colebrookdale township, on the N. E. side of a road. The spot is about three-fourths of a mile N. W. of the edge of the middle secondary red sandstone. Between this place and Swamp creek, lie several high hills, covered entirely with diluvium and fragments of sandstone. Hills of this description are common along the line, separating the middle secondary region from the primary hills of the

South mountains. At Swamp creek, we enter a valley, bounded on the N. W. by rounded knolls of the primary, and on the S. E. by the red sandstone (middle secondary.) This valley contains several exposures of limestone. The first of these, is on the west side of the stream, and belongs to Peter Motha. A little N. E. is the quarry of Jacob Oberholz, and beyond this, in the same direction, the limestone occurs on the premises of Henry Stauffer. At the first place, the strata dip N. E; at the second nearly S.

A narrow belt of the white sandstone, F. I., commences just east of the west branch of Perkiomen creek, and runs to the N. N. E., through Hereford township, to the line of Lehigh county. It is bounded on the S. E. by the overlapping red sandstone, and on the N. W. by the gneiss. The white sandstone shows itself on the main road, passing through the centre of the township; the rock dips towards the south. It is again well exposed on the east side of the main Perkiomen creek, where the Sumneytown road crosses.

We find a small insulated patch of the white sandstone in District township, about a mile and a quarter N. W. of Hoof's inn, where it occurs, surrounded by an elevated table land of primary rocks; the sandstone is of a coarse description. Passing from Hoof's inn, south-westward along the west branch of the Perkiomen, we meet another spot where the sandstone undoubtedly exists in place; this is about half a mile from the inn, on the S. E. side of the road. A little west of this, commences on the stream, a narrow valley, extending down to John Rush's forge, where the mountains approaching, close it in. The Mount Pleasant forges are situated near the lower end of this valley. Limestone shows itself a short distance above Rush's mill, (Hunter's on the map,) dipping S. S. W. It is again exposed in two fine quarries, one on each side of the creek, at David Schall's forge, (Thompson's on the map.) In the western of these quarries, the limestone considered the best, is of a dark blue color. According to our analysis, the rock in both localities, is highly magnesian, the composition being in other respects precisely similar; the lighter colored variety, containing if any thing, rather fewer impurities. The dip in both quarries is to the N. W. Near Mr. Rush's house, a little above his forge, there is another spot on a little creek, where the limestone has a slatey composition, and contains sulphuret of iron. Near this, they find a species of nodular chert in the diluvium, which can be shaped into hard but excellent whetstones. The soil has been raked over, and the loose pieces picked out and ground into a square form on a lap driven by a small water power. The whetstones were sold for thirty cents per pound in Philadelphia.

Iron Ores of the Gneiss.

The primary belt contains in several places viens of magnetic oxide of iron. These occur as regular lodes or veins, penetrating the gneiss and other primary rocks almost invariably in a direction coincident with the bearing of the strata. They might be taken, therefore, for interpolated beds, but for the occurrences of occasional branches and other irregularities which establish their intrusive origin. They agree in all their features with the larger and more numerous veins further towards the N. E. in the Highlands of New Jersey and New York.

Iron Mines of the Lehigh Hill.

Beginning with the part of the belt next the Delaware, the first vein we encounter is upon the Lehigh hill, about two and a quarter miles south of Easton, a few rods N. W. of the old Philadelphia road. The rock here is a mixture of quartz and feldspar, with occasionally a little epidote. On the southern side of the ridge, the strata are talcose. The vein of magnetic iron ore lies in contact with a syenitic dyke, consisting largely of green sahlite. This vein was formerly mined, but the work has been long since abandoned. The ore, which is very compact, appears to have a N. W. dip.

Durham Iron Mine.

Another somewhat noted locality, is that of the old Durham iron mine, which is on the top of the hill south of Durham creek, on the old Philadelphia road. This mine has likewise been neglected for many years, nor is it practicable in the present state of the works to ascertain with precision the value of the vein.

On the northernmost of the two primary hills, east of the Saucon, and about a mile N. E. of Hellerstown, a vein of magnetic iron ore shows itself in several places, though the quantity of ore here is probably not great. It is much mixed with quartz, though we obtained some tolerably pure specimens. A syenitic dyke, composed chiefly of sahlite and hornblende accompanies the ore, and seems to have been the chief object of attention to those who have undertaken mining here.

Brown argillaceous iron ore shows itself on the surface in some abundance, on the north side of this hill, near the junction of the primary rocks and the limestone. The appearances of ore are promising on Dillingham's farm, and much fibrous hematite is found on Hartman's, the next farm to the north. An open porous ore, in considerable quantity, is visible in a field on the latter place.

Fragments of magnetic iron ore occur in many places on the surface of the bold hill of primary rocks, south of the Lehigh, at Bethlehem, where some search has been made for it by digging. S. W. of Shimersville, near the east end of the same ridge, a vein of green sahlite, which has been mistaken for iron ore, shows itself near the summit of a hill. Close to this spot, some true iron ore has been found by us, the source of which is probably a little north of the sahlite. Epidote, mixed with iron ore, also occurs here. Further westward, near the summit of the same ridge, magnetic iron ore in a talcose rock is visible, near Shuber's, three miles from Bethlehem; it has not been dug for. The same variety of ore, of excellent quality, is found on the surface, near the top of the northern primary ridge south of Allentown, at a spot a little west of the Philadelphia road. A less magnetic variety is met with on the northern slope of the hill, a mile to the east of the road. Further to the S. W., the magnetic iron ore shows itself in the primary hill, three miles S. E. from Metztown, the spot being a little west of the Philadelphia road. It is on the southern side of the second primary ridge from the north, on lands of Messrs. Trine and Peter Fegely, the line dividing their tracts passing through the mine. The ore occurs in three regular veins, dipping with the adjoining strata, at an angle of 50° to the S. S. E. The southern vein is about a foot and a half thick; north of it occurs a stratum of rock, (gneiss,) eight feet across, in contact with which is the middle vein, separated near its outcrop into two branches, which at a little depth unite into one vein; this is bounded on the north by a stratum of rock about four feet in thickness, and directly in contact with this, is the third or northern vein, having a thickness of two feet. The rock which encloses these several veins, is a coarse regularly stratified gneiss, a mixture chiefly of quartz and feldspar.

Some miles to the south of the above, magnetic iron ore occurs on the border of Colebrookdale and Hereford townships, in the Mount Pleasant iron mines. In the north-eastern excavation, belonging to Isaac Berthou, the ore occurs between syenitic rocks, and is itself a mixture of rotten syenite and magnetic oxide. It is worked open to the air, in a drift ten or twelve feet wide, ranging E. of N. The dip here is 65° and a little S. of E. This mine, in the course of seven weeks of active operations, has yielded seven hundred tons of rich ore. The quality of the ore is however variable. A few hundred yards more to the S. W., is the mine owned by John Landis; it includes two large excavations, one of them twenty feet wide and sixty or seventy feet long, and sixty feet deep, pursuing apparently a regular vein or bed parallel with the strata. The ore removed at various times, amounts to about three thousand tons. The second excavation, bears a little N. of E. from the above. Two other excavations, on property belonging to Peter Disher, occur about two hundred yards W. of S. from these. Here the bed has a nearly east and west direction, and may probably be the same which contains the mines just previously spoken of. This ore, more compact than that of the other mines, is stated to have made a rather redshort iron. The excavations are on a less scale than the largest one on Landis' place.

It would be important at the present day to ascertain, if possible, the causes which led to the abandonment of the magnetic iron ores of the region under review. The ore which supplied the old Durham furnace, in Bucks county, now long neglected, is said to have made an iron of excellent quality. Should it appear that a deficiency of good fuel, not the want of ore, was the difficulty, we may hope to see these localities once more resorted to, now that anthracite coal, so easily had in this neighborhood, proves itself so admirably adapted for smelting those harder ores which require a disproportioned expenditure of charcoal.

Localities of Brown Iron Ore.

Brown or hematitic iron ore, in various forms, is often met with, in connection with the sandstone and limestone embraced in the chain of the South mountains. A usual place for the ore is near the junction of these formations with the underlying primary. Ore occurs in this position, near the border of the limestone, at the northern foot of the Lehigh hills, in many spots. Several excavations have been made about a mile in a direct line from South Easton, on the premises of John Bess. One of these was by a shaft about three hundred yards from his house. It is fifty-five feet deep, the first ten feet being through diluvium, the next ten feet through ore and ore ground, and the remainder of the distance through clay. Two other holes, each forty-two feet deep, were dug about three hundred yards from the above. In one of these, the covering of diluvium was fourteen feet thick, below which occurs the ore. The mining was done by the proprietors of the South Easton furnace, who paid an ore rent to the owner of thirty-seven and a half cents per ton. The geological situation of this ore is probably upon the sandstone, F. I. An unsuccessful excavation was made near the top of the hill, where gneiss and syenite, and other primary rocks were struck. About three miles westward from South Easton, a mine has been opened, at Jacob Woodring's, in a hollow between two spurs of the primary chain. It was not wrought at the time of our examination. The shaft here is said to be ninety feet deep, passing through diluvium and clay for fifty-five feet, before any ore was found. The ore is moderately rich, but contains some manganese. The limestone shows itself on the surface, about three hundred yards north of the ore. Westward of these localities, surface signs of ore are abundant, as at Ihrie's and Brotzman's, half a mile south of the Lehigh. At Brotzman's, where some manganese is associated with the ore, the diggings were made probably too high in the side of the hill, being apparently outside of the edge of the limestone. The ore here is rough and sandy, and contains compact black oxide of manganese in some abundance. A little hill, further west, on the same farm, lying within the limestone, shows a much better ore on the surface. On Richards' farm, in the same range as Brotzman's, but further west, surface ore is quite abundant, some of it being fibrous hematite. The next farm westward, presents the same indications. At the period of our exploration, the Lehigh Crane Iron company, whose works are situated on the Lehigh, three miles above Allentown, were about to commence some shafts on Richard's farm. They have since, it is said, purchased Ihrie's, so that it is now probable that the ores of this neighborhood will be well investigated. Above Richards', the primary formation approaching the river, cuts out the limestone, and consequently, the ore. But the limestone again showing itself higher up the river, a little ore has been dug above Bethlehem bridge, where, however, it is probably exhausted. Pursuing the same line to the S. W., we find an iron mine, (Swartz's,) at present neglected, about three-fourths of a mile S. W. of Emaus. At this spot there is only one mine hole, about forty feet deep. Smelted alone, this ore made a cold short iron, and was therefore usually mingled with other ores, principally with that from Breinig's mine. In some of the specimens found here, no manganese could be detected, though some of the ore has a manganesian aspect. Its geological position is in diluvium, lying near the border of the limestone.

The next locality of importance, is the old iron mine belonging to Oley furnace, nearly two miles N. W. from Fredensburg. At this spot the ore was dug from immediately under an outcrop of the sandstone, F. I., the digging running parallel with it for more than a hundred yards, and being eighteen or twenty feet deep, and eight or ten feet wide. This mine, now abandoned, furnished us some specimens from the side wall of the excavation; these are argillaceous and laminated, and of a purplish red color. A shaft unites the main excavation with another nearly under the first, having about the same direction, but descending more perpendicularly. This latter mine is from three to five feet wide; the wall is of primary rock, chiefly feldspathic and hornblendic gneiss, but sometimes entirely micaceous, and it contains, in certain places, magnetic and micaceous iron ore. The proprietors of Oley furnace propose reopening this old mine, having nearly completed a tunnel now six hundred feet long, intended to reach the lower excavation. The rocks passed through in the tunnel, are gneiss, syenite, hornblende, and micaceous slates.

On Pine creek, in Pike township, some diggings have been made for ore, about half a mile S. E. from Lobach's mill. The ore has the aspect of a talcose slate, charged with the oxide of iron; it has a laminated or rather a fibrous structure. There is a rather large excavation at Boyerstown, belonging to Daniel Feglie. At the time it was visited, the opening was filled with water. The rock accompanying the ore, is a light green soft variety of slate, dipping E. The ore itself is dull black, and contains many crystals of iron pyrites; it is said to have made a coldshort iron, and to contain copper, of which, however, no trace was visible. A short distance W. of S. from the above, occurs another mine, belonging to John Rhodder, where the ore is more compact. Both these localities are connected probably with the middle secondary red sandstone formation.

Middle secondary rocks, immediately bordering the South Mountains.

It remains for us, before quitting the geology of the South Mountain chain, to introduce here a brief description of the formations skirting the southern base of these hills. At Monroe, on the Delaware, a small creek separates the primary hills on the north, from the red sandstone of the middle secondary series. A little spur of syenite, running from N. W. to S. E., is exposed on the south side of the stream, where it breaks off abruptly. Its south-eastern end is overlapped by a thick bed of coarse calcareous conglomerate, forming a high crest nearly at right angles to the direction of the syenitic hill. This calcareous conglomerate is a very heterogeneous rock, consisting of pebbles of every size, some several inches in diameter, and derived promiscuously from all the older adjacent rocks, both primary and secondary. The cement uniting these pebbles is the substance of the neighboring red shale, impregnated with more or less carbonate of lime. A large, and in many cases a predominant proportion of the pebbles, belong to the contiguous limestone, F. II.

This conglomerate, identical with the Potomac marble of Maryland and Virginia, both in its features and geological relations, is here the uppermost stratum of the great middle secondary red shale and sandstone formation, which occupies so large a part of Bucks and Montgomery counties. Conforming to the prevailing N. or N. W. dip of that great series, its strata decline at a gentle angle towards the foot of the primary hills, abutting unconformably against the steeply uptilted strata north of them. At the south-east end of the above mentioned primary spur, we behold some patches of the ancient blue limestone yet adhering, the strata being much contorted, as if from the sudden rising of the syenite. Below the calcareous conglomerate, lies a very hard red siliceous sandstone, sometimes coarse, and containing pebbles, but sometimes very uniformly grained. Beneath this again occur fine grained red sandstone and shales. The calcareous conglomerate soon disappears going westward; no trace of it appearing on the old Philadelphia road, two miles from the Delaware. The next development of the calcareous conglomerate is west of Bursonton, where it forms a small belt running E. and W. across Durham creek. It shows itself again a little S. E. of Opp's tavern, in a low exposure east of the road. Passing Opp's tavern, towards Hellerstown, we meet hills covered with earth and loose pieces of the white sandstone, F. I. South of Seitz's limestone quarry, commences a chain of hills covered with diluvium and fragments of sandstone, on the top of one of which, that nearest the Hellerstown road, we find the conglomerate, which again occurs on the road leading S. W. to Coopersburg. A block of it was also noticed near the junction of the same road, and that leading to Allentown. The hill immediately south of the Hosacock creek, on the road from Shimersville to the corner of Upper Milford, consists of the conglomerate, which is here rather an incoherent rock, composed principally of primary pebbles.

The only remaining patches of conglomerate within the district, are in the southern part of Berks. A small exposure of it occurs on the Manatawny creek, below Rhoad's mill. Its beds here dip at an angle of about 10°. It next appears on the south side of Limekiln creek, Exeter township. The last and longest belt commences near the Perkiomen turnpike, and runs to the Schuylkill, rounding the southern point of the Neversink mountain, and crossing the Schuylkill, to terminate about two miles below the borough of Reading.

CHAPTER II.

Geology of a portion of the country lying N. W. of the Allegheny mountain, embracing part of Centre, most of Clearfield and Cambria, nearly the whole of Somerset, and parts of Indiana, Westmoreland and Fayette counties.

Beginning our description of the country, immediately N. W. of the Allegheny mountain, on the waters of Beech creek, in Centre county, where the operations of the previous year ended, we shall pursue the order heretofore adopted in these reports, by treating of the south-eastern belts and basins first, and tracing the formations in each of these, from the N. E. towards the S. W. The region now before us, like its extension towards the N. E., in Lycoming and Tioga, described somewhat in detail in my last annual report, consists of a series of long, narrow and parallel basins, separated by intervening table-lands and ridges, of different geological formation from the basins. All the strata within this wide tract of country, belong to only the five uppermost of our great Appalachian or lower secondary formations, from the red sandstone, F. IX., to the coal measures, F. XIII., inclusive. The whole having been lifted by a subterranean elevating movement, exerted along particular lines, the uppermost strata have been swept away by the accompanying floods, leaving the surface throughout these higher tracts, to consist of those formations which immediately underlie the coal, especially of the hard sandstones and conglomerates, composing F. X. and F. XII. The valleys between the ridges, being on the other hand, less exposed to the denuding violence of the currents, still retain the easily destructible uppermost formation, the coal measures, which the other districts have lost.

We shall enter, in the first place, upon a detailed account of the first or south-eastern basin, or that which follows the western side of the Allegheny mountain, through Clinton, Centre and Cambria. This basin was described in my last report, from the Loyalsock, on the N. E., to the head of the Tangascootac, where the examinations of 1839 terminated. Resuming the description at the latter point, where the waters of Beech creek interlock with those of Tangascootac, we find the coal measures, hitherto forming a narrow strip along the south branch of the Tangascootac, gradually widening and receding from the mountain, as we trace them towards the S. W. The main stream of Beech creek, flowing close to the north-west foot of the mountain, we meet with none of the productive coal measures immediately on either side, its hills consisting of the sandstones of F. XII., and only the great lower bed of sandstone of the coal series. Between these two unproductive strata, no coal nor any indications of it could be detected. The nearest outcrop of a coal seam, is one which occurs a little north of the turnpike, and which is about four miles N. W. of the eastern summit of the mountain. This coal lies between sixty and seventy feet above the top of the silicious conglomerate, which here forms F. XII. The bed is 4 feet 4 inches thick, and contains a thin seam of slate. The coal, which is good, has been mined to some extent. It may be traced over a considerable range of country, by a bench or little terrace, which marks its outcrop near the summits of the hills. This indentation, near the tops of the hills, rising and becoming indistinct at the edge of the coal basin, disappears entirely about a mile and a half E. N. E. of Snowshoe. Three quarters of a mile N. of the spot where the coal is opened, we discern the smut, which marks the outcrop of the coal at "Lucas's Sugar Camp," where an excavation, formerly made, has now caved in, hiding the thickness of the coal. The report throughout the neighborhood is, that the bed here is 9 feet thick, and contains a band of clay three inches thick.

At the principal mine, which is on the turnpike, the coal bed is 6 feet thick, including a layer of cannel coal, 6 inches thick, which runs through the middle. The roof here, is also of slaty cannel coal, the body of the seam being, however, a beautifully brilliant and pure glance coal. It has a very sensible dip, inclining at an angle of several degrees, and to an unusual quarter, the N. E. and N. Coal in considerable quantity is transported from this mine to the country E. of the Allegheny mountain, during the winter months.

Overlying the seam just described, we find, where the hills are high enough, another bench or indentation, marking a coal seam, between twenty and thirty feet above the former. This coal appears to be thin and unpromising. Iron ore, though in small quantity, occurs in a bed of brown shale beneath the first or lower coal seam.

In the country extending many miles N. E. from Snowshoe, we find a range of "High lands" along the heads of the north-western branches of Beech creek, where the rocks next beneath the coal measures occupy the entire surface. These owe their elevation to the first anticlinal axis west of the Allegheny mountain. Like the rest of the high belts, between the coal basins, the surface of this region is rugged and stony, and ill adapted to tillage, while it is wholly worthless in mineral productions. The iron ore, appertaining to the red shale, F. XI., may be met with in its usual position, just below the sandstone of F. XII., but in a country so wild and destitute of coal, possesses little value. Indications of this ore appear in springs, depositing much bog ore in a more accessible region lying south of the turnpike. These occur between the two branches of the Moshannon, on the line separating the lands of Jacob Gratz, Esq., from those of the Portland Lumber Company, and again about a mile up the Big Moshannon, south of the point where the "Indian Path" crosses it.

In this neighborhood, the first coal which shows itself as we pass westward from the ridge of the Allegheny, occurs in the hills along the Indian path, near the mouth of the Little Moshannon. Two benches, marking two different coal seams, were traced along these hills. Descending to the Little Moshannon, we meet the "Brown Rock," or the sandstone below the lowest coal seam, finely exposed in the steep hill slopes, and just beneath this, the coarser beds of F. XII. The strata here dip 4° to the N. E. Indications of two good coal beds were met with, where the "Indian path" diverges from the Karthaus road.

From a little above the mouth of the Little Moshannon, nearly to Philipsburg, no coal was discovered along the S. E. side of the main or Big Moshannon. But at Philipsburg and southward, up Cold stream, coal occurs abundantly to within a mile and a half of the eastern crest of the mountain. Six miles N. E. of Philipsburg, there are indications of the ore of the red shale, F. XI., on the turnpike near the Moshannon. It lies under the coarse sandstone F. XII. which here constitutes the principal part of the hills. This ore is deserving of further investigation. Below this, on the creek, springs depositing bog ore, are frequent. The red shale, F. XI., forms the bottom of the valley of the Little Moshannon, near its mouth.

Philipsburg.

The principal mines now wrought in the valuable mineral district around Philipsburg, are on the north side of the Moshannon, opposite the village. The following section, compiled from measurements obtained at this spot, will show the number and relative position of the several beds:

Section, Descending.

Upper strata of moderate thickness, not determined.

Coal,	4	feet.		
Fire clay,	2	"		
Calcareous slate,		"	8	inches.
Bright blue compact shale, (indurated clay,)	1	"	2	"
Ferruginous shale,	2	"		
Blue limestone, ferruginous,	5	"		
Sandstone and slate,	19	"		
Coal, of excellent quality,	4	"	4	"
Fire clay,	2	"		
Ferruginous limestone, passing into iron ore,	2	"		
Sandstone,	16	"		
Coal, in the bed of the creek,	1	"	8	"

The middle coal seam, represented in the above section, the only one now wrought, is mined to a considerable extent. It is four feet four inches thick, is of sound texture, and excellent quality throughout, and will afford solid blocks of coal the whole thickness of the bed, and as much as eight feet in length. The upper coal bed of the section is stated to have been opened formerly, and found four feet thick. From the low position of these beds, they must range through a wide extent of country. A shaft, sunk by us two miles west of the above locality, brought to light a bed of coal, which is either the uppermost of the section or a still higher seam. The strata passed through, will be seen from the following *section:*

Olive shale,	10 feet.
Coal,	4 "
Fire clay, gritty,	2 "
Decomposed, ferruginous, calcareous sandstone,	3 " 6 inches.
Nodular limestone, in shale.	

Throughout the country immediately north of Philipsburg, a brown iron ore is found, loose in the fields; it is possibly derived from the ferruginous stratum mentioned in the section. The appearances at several localities are such as should induce a more thorough examination by the proprietors. One spot is at Runk's, on the turnpike, three miles N. W. of Philipsburg, and another two miles north of the village. Examinations were once made at the latter place for hematitic ore, with the anticipation that it would prove like that of the limestone valleys east of the mountain; but the operations were abandoned. A third locality is on Geerhart's farm, near the creek, a mile and a half S. W. of Philipsburg. Here loose pieces of limestone occur, associated with the ore. It is probable that all these exposures belong to the same part of the formation.

Coal occurs in abundance on the farm of John Goss, about five miles W. S. W. from Philipsburg, and six miles N. W. of the summit of the mountain. This is on the N. W. side of the Moshannon, and a mile and a half S. E. of a high ridge, supposed to contain the first anticlinal axis, here much flattened, N. W. of the mountain.—The following section exhibits the position of the coal at this place:

Section descending.

Coarse brown sandstone, thinly bedded.	
Black slate—roof of the coal.	
Coal, too near the surface to be worked,	7 feet.
Undetermined strata,	20 "
Coal,	2 "
Undetermined strata,	15 "
Coal, separated into two beds, by a seam of interposed slate, 8 inches thick, 2 feet from the bottom,	8 " 10 inches.
Limestone, thickness not ascertained.	
Kidney ore, quantity unknown.	

The lowest coal seam being separated into two beds, only the uppermost, which is 6 feet thick, is worked. It affords an excellent sound coal, free from sulphur and slate. This seam exhibits that tendency to a columnar structure which is so common a feature in the coal of all the basins immediately contiguous to the Allegheny mountain. From its low position, in reference to the other strata, it ranges over a considerable extent of country, though all attempts to identify it have hitherto failed. The uppermost coal seam, in the section, occurs so near the top of the hill, as to be too soft and dirty to work; from the same cause it does not spread over much extent of surface. Coal occurs at two or three other places in this neighborhood, showing a thickness of about 4 feet; but, whether these localities belong all of them to one seam or to two, could not be ascertained. From Philipsburg, S. W., the centre of the basin coincides very nearly with the general course of the Moshannon creek, the strata on each side, dipping gently towards the stream. The coal beds, along the S. E. side of the basin, here, near the top of the mountain, do not correspond with those above described. They have been developed in the dividing ridge, between Coal stream and Trout run, called "coal hill." The lowest bed, at this place, has its outcrop about a mile and a half N. W. of the summit. It was here discovered and opened by us, and found to contain 5½ feet of coal, resting on more than 6 feet of excellent fire clay. The fire clay lies within 6 or 8 feet of the conglomeritic rock, F. XII., the "Brown Rock" being here absent. About fifty feet above this coal bed, occurs another, 9 feet thick, divided into two seams, by 10 inches of interposed slate, two feet from the bottom. The upper division, 6 feet thick, alone is worked. This coal is of sounder texture than most of that near the mountain, admitting of being mined in large square blocks. It is free from sulphuret of iron. This same bed has been opened, two miles nearer to Philipsburg; it and the lowest seam have been estimated to occupy as much as four square miles of surface, in the country between Trout run and Cold stream. The thick upper bed, here mentioned, lies at a level 250 feet below that of the summit of the mountain, at "Emigh's Gap," which is about four miles distant. Should the proposed railroad over the mountain take the route of this gap, or that of Logan's Narrows, fourteen miles distant, the coal here spoken of, would become of great importance. In Coal hill, we have indications in the benches on the surface, of at least three other coal seams—the smut only of two of which being penetrated; one proved to be 18 inches thick, and the other 4 inches; no attempt was made to open the uppermost. These benches, or indentations on the sides of the hills, when distinctly marked, are unerring indications of the presence of beds of coal. The dip is about 5° N. W.

Examinations were made in this vicinity, in search of the iron ore of the red shale F. XI., some old openings giving promise that the ore might here be found. The excavations, commenced by ourselves, were prosecuted with much spirit by Mr. Philips, who has shewn great zeal in developing the mineral resources of the rich neighborhood before us. Ore has been found in several spots accompanying the white and red clay, or decomposed shale, immediately below the grits of F. XII., but the coming on of winter has prevented the proprietor from determining the thickness of the deposite and quality of the ore. A rather thick ferruginuous bed does occur here, but no specimens have yet come to hand, enabling us to pronounce upon its value. Should this ore of F. XI. prove productive, the place would unite many advantages for the establishment of iron works, lying near the fertile valleys east of the mountain, and possessing an abundant supply of coal, excellent fire clay and sandstone, a sufficiency of limestone and excellent timber, both oak and pine, and an ample water power on Cold stream. The country, here abounds in excellent white pine which is always best towards the heads of the streams. Cold stream now drives a large saw mill and a forge. During the winter months, coal in considerable amount is hauled by the route of Miller's gap, into the valleys S. E. of the mountain, where it is sold at the rate of fifteen cents per bushel.

On the eastern fork of the west branch of Muddy run, on the county line dividing Clearfield from Cambria, there occurs a large deposite of rich bog ore, (see analysis,) covering about two acres, and further down the run, for a mile and a half, the springs in many places precipitate the same ore in the form of a red ochre. This material is probably derived from the red shale, F. XI., the surface on the western flank of the mountain sloping rapidly to this point. A sandstone corresponding in character to F. XII., shows itself in the steep slope above the flats of the stream; it is probably between 30 and 35 feet thick. Four other benches appear higher up, the second of these, ascending, is watered by a spring, and the third and fourth exhibit signs of coal and fire clay. It is said that springs depositing bog ore occur in many places along the summit of the mountain, in a position answering to that of F. XI., and in some places in sight of the furnaces and forges in the valleys below.

Mount Pleasant.

In this neighborhood we meet with numerous indications of coal and limestone, though the inhabitants have rarely been at the trouble to develope either. Only one coal bed, 2 feet thick, has hitherto been opened, though the benches in the hills, and the smut exposed in the fields, imply the existence of three other seams.

Along *Clearfield creek*, near Blain's run and Turner's run, coal, fire clay and limestone are abundant, and judging from the evidences of iron ore, enough of this mineral may possibly be found to make this a valuable locality. A little up Blain's run, there is a bed of good coal, 5 feet thick, near the level of the stream, and under it fourteen feet of fire clay, a part of which is well adapted for making stone ware, and the rest fire brick. A manufactory of the latter, owned by Mr. Campbell, has been established here, which yields sometimes fifteen hundred bricks per day. In making the fire bricks, the clay is ground *dry* in a wooden trough by a heavy stone roller. The bricks are sold *on the spot* for $20 per thousand, while some are carried in rafts down the creek and the Susquehanna, and some hauled east of the mountain and elsewhere. Different varieties of good stone ware have also been manufactured to some extent, other seams of coal and indications of iron ore occur higher up in the same hill above the coal already spoken of.

Further down Clearfield creek, a little above Porter's run, Mr. Wright owns three beds of coal, two of which are each 2 feet thick, the other 3 feet. He has also a bed of limestone 4 feet thick. Good kidney ore, sometimes in one, sometimes in three bands, may be traced along the edge of the creek for several miles. The nodules are occasionally very large, but it is feared the quantity is insufficient to warrant mining. In this neighborhood other beds of limestone were met with.

Between Mt. Pleasant and the Portage Railroad, the nature of the country is such as to render a minute exploration extremely difficult, so generally are the strata concealed at their outcrop by the soil, and so few have been the developments undertaken by the inhabitants. The prevailing formation is that of the coal measures, beds of coal and limestone being occasionally met with, but no seams of much importance have hitherto been discovered. The unpromising nature of the country prevented our devoting that large amount of time to it, without which, it was soon ascertained, nothing effectual could be accomplished towards determining its mineral resources.

The Second or West Branch Coal basin.

Describing the several coal fields in their order towards the N. W., the next which claims our attention is the second, or West Branch basin. Tracing it from the N. E., to the S. W. as a continuous trough of coal measures, it reaches the river Susquehanna near the mouth of Young Woman's creek, which it crosses, passing afterwards Kettle creek, near its mouth. But in this part of the country, immediately north of the river, the basin is very shallow; only a thin remnant of the coal measures capping the very highest hills. West of the mouth of Kettle creek, coal was once opened, three miles from the river up Cook's run, where, it is stated, the coal was 4 feet 2 inches thick, parted in the middle by 2 inches of slate. At a somewhat lower position in the hill, between F. XII. and the "brown rock," a bench occurs which may denote another coal, though none is at present known to exist here. A bed, corresponding to that above mentioned, is said to have been once opened on the south side of the river, opposite the mouth of Cook's run. A little S. E. of the last locality, the land rises by the cropping out of the lower formations that fold gently over the anticlinal axis separating the first and second basins. At the mouth of the Sinnemahoning, the red and grey flaggy rocks reach a height of fully one hundred and fifty feet above the water, but only emerge above the river flats at the mouth of Cook's run. The hills around the head of Cook's run are very high, but consist of formations which forbid the hope of finding coal. The iron ore of F. XI., may perhaps underlie the conglomerate on the hills, though the probability is slender of its being of sufficient thickness to be profitable.

From a point several miles below Karthause, the coal measures in the river hills are quite productive, embracing several bands of iron ore, limestone, and some excellent coal seams; and near Three runs, we have besides, promising indications of the ore peculiar to the upper beds of F. XI. The coal basin deepening gradually as we ascend the river, the large upper bed at Karthause does not enter the hills, until we pass above the neighborhood of Three runs. At the latter locality occurs a bed of coal, 3 feet 2 inches thick, which has been opened, associated with a layer of *limestone* and one of *fire* *clay*. Openings were once made into a coal bed and band of iron ore on the south side of the river, at a point high up in the hills; but the success of the exploration is unknown. Tracing the coal rocks back from the river for two or three miles in this direction, we find them gradually rising until they appear, finally, only in the highest knobs, beyond which they are succeeded by the coarse beds of F. XII., expanded over the elevated tract designated "Highlands" on the State map.

At Karthause, the coarse sandstones and pebbly rocks of the upper part of F. XII. occupy the bed of the Susquehanna. The strata here dip about 5° towards the N. W., and preclude therefore any hope of finding the *iron ore* associated with the upper layers of F. XI. At Three runs, lower down the river, the gentle rising of the strata may bring this part of the series into view, as already mentioned. The ore was here sought for just previous to the abandonment of the enterprise at Karthause. A still more suitable spot will be on the S. E. side of the river, directly opposite the Karthause mines, on a small run divided from the river by two knolls. Here the conglomerate, F. XII., forms a perpendicular wall, twenty-five feet high, the stratum dipping at an angle of 5°. The iron ore of F. XI. should be searched for immediately at the base of this rock. Mr. John James, the chief miner of the Karthause furnace, when it was in operation, compiled with considerable care, a general section of the strata from the water level to the summits of the hills near the furnace. This we shall append here, with a few trivial additions of our own:

Section of the Strata at Karthause.

Summit of the hill, five hundred and sixty-five feet above the river.

Slaty sandstone, said to contain a coal bed 2 feet thick,	79 feet.	
Black slate,	1 "	
Coal, elevation 479 feet,	6 "	
Fire clay, of inferior quality,	2 "	6 inches.
Brown sandstone,	45 "	
Coal,		10 "
Hard fire clay,	2 "	
Limestone, siliceous,	3 "	6 "
Shale, with poor iron ore,	1 "	
Brown sandstone,	25 "	
Coal,	3 "	

Slate,	1 feet	6 inches.
Grey sandstone,	37 "	
Coal,	3 "	2 "
Shale, containing about 26 inches of good kidney formed iron ore, elevation 345 feet,	11 "	
Coal,	1 "	
Brown sandstone and slate,	21 "	
Coal, including 3 inches of slate 1 foot from the top,	3 "	9 "
Fire clay,	2 "	6 "
Brown sandstone,	35 "	
Coal,	1 "	6 "
Fire clay, ferruginous,	3 "	
Shale, containing about 25 inches of good iron ore, called the "red ore"—elevation 268,	11 "	9 "
Shales and slates, with a little unimportant iron ore,	22 "	
Coal,	1 "	
Sandstone, the "brown rock."		
Thin coal seam,		
Conglomerate and coarse sandstone of F. XII., down to the river, amounting with the brown rock, to	240 "	

There are in all ten coal seams of greater or less size in this part of the basin. The thick bed near the top is the only one hitherto mined. Lying near the summits of the hills, it does not, in the immediate vicinity of the furnace, occupy more than about forty-three acres, though it enters a few small knobs to the north and to the S. W., where the covering strata are thin. This bed is altogether 6 feet thick, but this includes 1 foot of inferior coal, near the top, which is not mined; the remainder of the seam consists of very excellent coal, adapted to making a superior coke. Lower down in the measures, occur two important beds of iron ore. One of these, at an elevation of three hundred and forty-five feet above the river, is estimated to contain in all 2 feet of good blue kidney ore in 11 feet of shale. The other stratum lies at an elevation of two hundred and sixty-eight feet. It also exhibits about 2 feet of good kidney ore, in a stratum of shale less than 12 feet thick. This band is locally called the "red ore," and is of a different variety from that above it; they are both of excellent quality.

The limestone of this neighborhood, is for the most part inferior; only one bed of it, 3½ feet thick, occurs in the series. Besides the thick upper coal, there are three others of a size suitable for mining, one of which, 3½ feet thick, and the two others, each 3 feet, but none of these supply as pure a coal as the main seam.

Nine miles above this, on the river, the "red ore" has been found, and is stated to be thicker than at Karthause. Three miles higher up, there occurs a bed of coal near the summits of the highest hills, which measures 4 feet 4 inches in thickness; this, there is some reason to suppose, is part of the main Karthause seam. Between the two localities mentioned, appears a bed of limestone. In this neighborhood the sandstone rocks of F. XII., occupy a position near the flats of the river. The coal measures spread but a moderate distance from the river on either side, the underlying conglomerate of F. XII., rising out and capping the hills every where from three to five miles off from the river.

Much difficulty was experienced in the district around the town of Clearfield, in identifying the coal seams of neighboring localities, and after close investigation, aided by frequent diggings, the stratification remains quite obscure. We are in doubt to what causes to attribute the intricacies of the region; whether to local displacements of the strata, sudden variations in their thickness, or an insufficient collection of facts. Our descriptions will therefore be necessarily restricted to a mere account of the position, and economical importance of the leading beds at several localities, leaving for a future day the task of generalizing our results.

The largest and best coal seam, in this division of the basin, is that on the property of Mr. Thomas Reed, near the bridge over the Susquehanna, two miles from Curwinsville. It lies between eighty and ninety feet above the river, dipping at a considerable angle to the N. W. The coal bed is here 3 feet 6 inches thick. We have been told, that one hundred thousand bushels of this coal have descended the Susquehanna to Harrisburg. It forms an excellent fuel, as it contains but little sulphur. Like most of the coal beds of the south-eastern bituminous basins, it affects a species of columnar structure, being traversed by innumerable vertical fissures, which render it somewhat friable. For its composition, consult the chapter of analyses.

Attempts have been made to trace the above coal seam into the neighboring hills, where however, no bed corresponding to it in thickness and quality has been discovered. Several other seams exist in the accompanying strata, but none of them possess economical value. Underneath the coal seam, above described, is a bed of *limestone*.

On the north side of the river, three quarters of a mile above the town of Clearfield, occurs a stratum of fire clay, of good quality, and 8 feet thick. Its position is a few feet above the river bank.—*Oolitic iron ore*, seemingly of good quality, abounds in the upper part of the fire clay, 2 feet of which appears to contain about 1 foot of ore. A layer of similar oolitic ore, supposed to be the same, exists on Clearfield creek, near the water side, at the point of the long bend, amounting to nearly 2 feet of ore balls in close contact. It it is here associated with fire clay, and a few thin bands of coal and coal slate, containing more ore. In the steep hill above this bed, lie two layers of *limestone ;* the lowest of these is a pure rock, 6 feet thick. Several beds of coal are also known to exist here; but, as in the former locality, they are all of unimportant thickness. The proper place in the strata, for Reed's coal, is above the thick limestone, where there is a space of fifteen feet of materials not developed. The above mentioned bed of ore, lying adjacent to the river, is easily accessible.

At the town of Clearfield, a seam of good coal is wrought to some extent. It lies between forty and fifty feet above a stratum of sandstone that occupies the bed of the river. It measures 2 feet 10 inches in thickness. The outcrop of another bed shows itself near the top of the hill, a mile south of the town; this seam has no where been accurately developed. The first spoken of, is conceived to be the same with Owen's bed, two miles up Clearfield creek, where the coal is 3 feet thick, and of excellent quality. Over it are the indications of three other seams. It has been mined in another place, three miles up the creek, where its thickness however only amounts to 20 inches. Though several other coal beds occur here, this lower one is the thickest thus far discovered.

Besides the band of *iron ore* already noticed, several varieties of this mineral occur along Clearfield creek. A rather peculiar, rough looking ore, in large masses, some of them more than one hundred pounds in weight, strew the surface of a tract of land belonging to Perley, Blake and Crane, of Boston, lying a mile south of the old turnpike. The mineral is heavy, but evidently not very rich in iron. For its composition, consult the analyses. A somewhat similar ore, possibly a part of the same bed, is to be seen, on the east side of the creek, at Beer's, where, though the surface indications are encouraging, the quantity of the ore has not been proved. A peculiar compact shale or indurated slate clay, of a bright blue color, accompanies these ores, and is likewise found in association with another variety, three miles up Little Clearfield creek. Here the shale, which is 12 feet thick, is less blue; scattered through it, are small balls of ore. Beneath this is a considerable quantity of a coarse ore, in very elongated, somewhat cylindrical masses, like bars of pig metal; it does not appear to be rich. On the old turnpike, near the tenth mile stone west of Philipsburg, appear two seams of good kidney ore, requiring further digging, in order to determine their value. On the new turnpike, near Roaring run, a spring issues from directly beneath loose masses of conglomerate, and deposites the red oxide of iron in a large bog. This spring forms a stream which propels Bloom's saw mill. It was impossible to decide whether the conglomerate belongs to F. XII. or not, though the ore spring renders it probable, that we have here the contact of that formation with F. XI., indications being sufficient to justify a more minute examination by the owner, for the hard ore at the top of the red shale.

Between Little Clearfield creek and Mount Pleasant, the whole country consists of coal measures, none of the lower formations shewing themselves in the position of the anticlinal axis, which elsewhere separates the first and second basins. The chief feature, indicating the existence of an anticlinal axis between Philipsburg and Clearfield, is a high dividing ridge, where, however, none of the lower rocks make their appearance. The obscurity in the outcrop of the strata along Little Clearfield creek, prevented our ascertaining clearly the stratification in that neighborhood, to determine which, would have required more time than we were possessed of. This valley shows several good beds of limestone, and some coal. At Mr. Wright's, above Porter's run, there are three coal seams, two of which measure each 2 feet, and the other three feet thick. There is besides, a bed of limestone, 4 feet thick; one, in some places three layers of good kidney ore, lying in shale, can be traced along the banks of the creek for several miles; the lumps are occasionally very large, but the whole quantity hardly sufficient to pay for mining.

The country occupying the prolongation of this basin, from Curwinsville to the Conemaugh, was not explored by us, its examination being unavoidably postponed to another season.

The Third or Bennett's branch basin.

Between the north-western margin of the Karthause basin, and a third and parallel trough of coal measures on Bennett's branch, we pass a wide tract of elevated barren country, consisting of the coarse rocks of F. XII., which are here lifted to the surface by a broad and flat anticlinal axis. This axis of elevation, dividing the two coal fields, crosses the east branch of Sinnemahoning a few miles above its mouth; then, curving gently southward, it passes the Sinnemahoning at the mouth of the Driftwood branch, to range in a W. S. W. direction, through the high land, dividing the waters of Clearfield creek from those of Bennett's branch. The belt of country immediately along this line, presents few mineral features of importance. The sandstone and conglomerate rocks of F. XII. cap the highest hills. Indications of iron ore occur in a few bog ore springs, visible near the Sinnemahoning, but the great height, and steepness of the hills, at the very summits of which it must lie, would render the ore, even if abundant, difficult of access.

The synclinal axis, marking the middle of the third coal basin, crosses the east branch of the Sinnemahoning, about ten miles above its mouth, and the Driftwood branch at the same distance from its outlet, following the course of the stream. On the west side of the Driftwood branch, one bed of coal has been discovered and opened near the level of the highest lands. A body of productive coal measures may possibly exist between this and Bennett's branch, though from the obvious shallowness of the basin here, the existence of such appears improbable. The country is excessively wild and rugged. The apparent extension of the coal measures for five or six miles N. W. of Bennett's branch, up Hick's run and Trout run, is a matter which claims some attention on the part of the proprietors of lands in this quarter.

At *Caledonia*, on Bennett's branch, the basin becomes productive, the stratification embracing coal, iron ore and limestone. This place is on the main stream, about six miles above the mouth of Trout run. The hills on either side attain an elevation of about five hundred and fifty feet, which they preserve for three or four miles back from the stream. On the S. E. margin of the basin, the rough rocks of F. XII. are visible on the Karthause road, four miles south of Bennett's branch, dipping gently to the N. W., and this dip continues to the north side of the stream, the strata of F. X., two miles above Trout run, showing an inclination of nearly 5° in that direction. This northern dip, however, must soon change, for on Wolf run, between six and seven miles N. W. of Bennett's branch, the coarse rocks of F. XII. again rise in the contrary direction, and cap the higher hills that bound the basin on the N. W. .

Although F. XII. at Caledonia, (Warner's,) lies but little above the flats which border the stream, yet four miles lower down the valley, in a N. E. direction, the subjacent rocks of F. X. appear at least two hundred feet above the level of the water. This is due chiefly to the gradual ascent of the basin in that direction, and but slightly to the fall of the stream; hence the probability of finding but a very limited amount of coal measures still further to the N. E., on Trout run and Hick's run. In the grey slaty sandstones of F. X., there occurs a bed of indifferent sandy limestone, about 4 feet thick. This contains many fossil shells and other marine remains, including those of one or two species of fishes. Associated with this limestone, we find many little yellowish balls of excellent iron ore. Between formations X. and XII., we meet with indications of the bed of iron ore, everywhere so prevalent in F. XI., which, as a separate formation, seems itself to have thinned out. Up a little run, to be seen a mile and a half below Caledonia, we find a deposite of the soft bog ore derived, as usual, from springs flowing out of this part of the strata. We discovered a fine natural exposure of the bed of hard ore, before unknown, about a mile and a half above Caledonia, on the edge of Bennett's branch. At the latter place, the current has cut away the loose rock and covering soil, leaving the ore in view under the overhanging sandstone of F. XII., the bottom of which is within eight feet of the water. Immediately beneath the sandstone lies 1 foot of black shale and, under this, 3 feet of brown shale containing scattered nodules of the ore, underlaid by a solid bed of the ore, forming, with a very little shale, a bed between 3 and 4 feet thick. This overlies a band of fire clay. This ore somewhat resembles that found at Astonville, and described in my fourth annual report. A recent slide of earth and loose rock, somewhat concealing the layer, prevented our ascertaining its thickness with perfect precision. This promising exposure is on a tract of land stated to belong to a lumber company of Portland.

Formation XII., the exact thickness of which was not satisfactorily determined, varies from a moderately coarse sandstone to a rough quartzoze conglomerate in which the pebbles are occasionally larger than a turkey's egg. Large masses lie loosely scattered in great abundance. They present blocks of all sizes and every degree of relative fineness of texture, and admit of being easily split into fragments adapted to almost any building purpose. The whole stratum is probably about 100 feet thick, its lower edge, at Warner's, occuring about forty feet above the level of the stream. Above the top of F. XII., the strata, which should contain coal, offer no exposures throughout a thickness of many feet. Near the head of a small stream, four miles below Caledonia, the upper edge of the sandstone is caught, lying about three hundred feet above the flats; and very near this is a bed of compact yellowish shale, 4 feet thick, somewhat resembling externally, a limestone. In no other place was this bed, or any other, visible near the top of F. XII. The "brown rock," so usually met with in this position, was not recognized. The first stratum met with in the ascending order, was a dark blue shale, which occurs about forty feet above F. XII. We had some reason to suppose that the interval contains a bed of coal. From the level of this shale upward, a tolerably minute section of the strata was procured by the aid of the pick and shovel, and the results contrasted with observations made in adjacent ravines and gorges. Some of the beds, thus developed, were found exposed on Warner's run, and other thin layers detected on Mead's run, lying a mile to the east. From these various data, the following somewhat detailed section of the rocks has been compiled. The more complete portion of the section terminates at the great bed of sandstone, 100 feet thick; but we have introduced several of the overlying beds in the order in which they were observed, ascending the highlands north of the sources of the above streams.

Section of the coal measures on Bennet's branch near Warner's:

White sandstone, coarse, approaching a conglomerate,	50 feet.	
Coal, indicated by a bench,		
Yellowish sandstone; there is a limestone either above or below this bed,	40? "	
Brown shale, thickness unknown,		
Coal, opened at Brockaway's, on the turnpike,	2 "	6 inches.
Fire clay,		6 "
Sandstone, grey, slaty, with some interstratified shale,	100 "	

Black and dark shales, containing kidney ore,	20	feet.		
Coal; the upper 6 inches cannel coal,	3	“		
Fire clay, dark colored,	1	“	6	inches.
Fire clay, blue, of good quality, the upper part containing many balls of iron ore,	8	“		
Ore stratum, with fire clay, 3 feet 6 inches, comprising oolitic iron ore,			3	“
Blue fire clay,			12	“
Oolitic iron ore,			6	“
Blue fire clay,			6	“
Oolitic iron ore,			3	“
Blue fire clay,			12	“
Compact shale, blue and yellow, resembling externally, a limestone, its upper part containing oolitic iron ore,	8	“		
Olive shale, containing shelly ore,	8	“		
Blue sandstone,	1	“		
Shale, with iron ore; lower part of the stratum sandstone; the ore is abundant,	45	“		
Olive shale,	15	“		
Coal,	1	“	6	“
Blue slaty sandstone,	5	“		

Limestone stratum with fire clay, 6 feet thick, comprising:

Limestone,			10	inches.
Fire clay,			12	“
Limestone,	3	feet.		
Fire clay,	1	“		
Dark colored shale, the lower 4 feet, embracing ore,	10	“		
Olive shale,	2	“		
Coal,—inferior, being slaty cannel coal,	1	“	6	“
Black shale,	3	“		
Coal, of good quality,	5	“		
Black shale,	2	“		
Sandstone,	10	“		
Black shale,	4	“		
Sandstone and olive shale, with kidney ore,	30	“		
Limestone,	4	“		
Sandstone,	10	“		
Dark bluish shale,	6	“		

On several of the adjoining runs, the iron ore has been dislodged from its shale in great abundance, and the indications are such that we believe it might be profitably mined in several drifts on the same stream. On the Clearfield road, one mile from Caledonia, there is an exposure of iron ore on the road side, but the exact place in the series, occupied by this section, has not yet been ascertained. It has been thought to be the same band as the "red ore" of Karthause. Its position is not far above the upper edges of the conglomerate, F. XII. It consists of balls of heavy ore, embedded in shale, one fourth of the lower 3½ feet of which consists of the ore. The excavation, made to expose it, evidently did not bring the whole of it to light.

The five feet bed of coal was discovered and opened by us where the above section was made, but we afterwards ascertained that it had been uncovered on other streams. This seam, consisting of sound coal without any slate, measures in one place 5 feet 2 inches in thickness. The lower limestone is blue, but it is not compact or close grained. The upper limestone, probably the best of the two, is less blue, and of a finer texture. The blue and yellow compact shale, somewhat resembling a limestone, is a singular layer; it is often variegated, resembling occasionally a breccia, and is susceptible of a good polish. Iron ore occurs abundantly in the shales above the second limestone, but in consequence of the difficulty we encountered in opening these beds and ascertaining the exact quantity of ore, we cannot venture to say more than that the indications are very promising. The quantity of the oolitic ore is considerable. The fire clay on Mead's run is a rather heavy bed, and resembles precisely that worked at Farrandsville. The 3 feet bed of coal, containing in its upper part 6 inches of cannel coal, supplies a fuel much esteemed by the blacksmiths; besides occurring at this locality, it is found four miles north of Bennett's branch, at a spot, a mile east of the turnpike. In the upper part of the coal measures, we met with one or more beds of fossiliferous limestone.

The facilities for mining the iron ore, coal and limestone in this neighborhood, are certainly considerable, and these minerals lie, all of them, convenient to an ample water power, which might be derived either from Bennett's branch or Laurel run, affording if necessary, a fall of fifty feet, and water enough for extensive iron works. The iron might be conveyed to market by the Susquehanna, on rafts, the timber of which will pay, it is thought, all the expenses of the transportation. But these could only run during the spring, and occasionally in the summer, in times of freshet. During the winter, it is said, there is good sledding along the river on the ice. To reach a western market, it would be requisite to haul the metal about twenty miles, upon a pretty good road, to the Clarion river, whence it could be sent in rafts and arks from Ridgeway to Pittsburg. The neighboring country is capable of maintaining ultimately a considerable population.

The basin, of which we have here been treating, extends to the S. W. up Bennett's branch. It was found to be rich in coal and limestone for ten or twelve miles above Caledonia. But the natural exposures of the strata near the sources of the streams are very few, and we found it almost impossible, with the limited time we had at our command, to procure a good idea of the stratification. The basin, both on the N. W. and S. E. sides, is bounded by high barren table lands, in belts about five miles wide, capped by F. XII. The ridge of high lands on the N. W. is called Elk mountain. A few of the knobs on the flanks of these broad ridges probably contain one or more of the lower coal seams. The intervening valleys of denudation are fertile and sparsely populated.

Want of time did not permit us to complete the exploration of this third basin in its prolongation south-westward. Merging in that direction into the general basin of the western counties, its limits and stratification will be more clearly defined, when the opportunities of another season enable us to unite and identify the minuter features of the geology, west of Chesnut ridge and the Elk mountain. Sometime was spent in the exploration of the tract along the Conemaugh, immediately west of Chesnut ridge, presumed to be a portion of the present coal basin; but the results of this examination belong more properly to a description of the great, westernmost basin as a whole, for which we are not yet fully prepared. At present, therefore, I shall content myself with a brief statement of a few particulars concerning some of the more valuable deposites bordering the Conemaugh.

About two miles east of Blairsville, at Christopher Hill's, on the canal, we discovered the iron ore of F. XI. It proved to be about 1 foot 6 inches thick, and to consist of irregular balls in close contact. The indications are, that the mass of ore, in from the crop, is more solid. The limestone, characteristic of F. XI., is here seen *immediately* under the ore. Only about two feet of it is exposed.

It contains a few fossils. The ore is exposed in several places ascending the river for a mile, nor does it disappear as we descend the river for an equal distance. It is indicated by a distinct terrace or bench, directly over which we behold the bottom bed of F. XII. This iron ore of the red shale was also found in the bank of the canal and river, opposite Jacob Hill's, three quarters of a mile below Christopher Hill's. A nearly solid band of it, 18 inches thick, is there exposed. It is a compact ore of rather heterogeneous structure; consult the analysis. Directly over it lies a layer of reddish shale, 3 feet thick, containing many nodules of ore, and upon this a bed of flaggy sandstone, 15 feet in thickness. This seems to be all that remains here of the usually massive stratum F. XII. Overlying the sandstone, at a small interval, is a bed of good limestone proved to be at least 26 inches thick. Not far above this, occurs a coal seam 4 feet in thickness. This has been opened at Lymangood's, near the foot of Chesnut ridge, where it closely adjoins F. XII., which is there in the form of a massive bed of coarse sandstone. About fifty feet above the upper edge of this formation, we find a large bed of coal, varying from 6 to 7 feet in thickness. This seam, which is here in high repute, rests on a layer of excellent fire clay, from 1 to 2 feet thick, underlying which, is a band of limestone 2 feet thick. Below the latter, lies 3 feet of shale, containing iron ore, probably to the extent of one-half of the whole mass. There is another bed of very good limestone, higher up in the hills, said to be between 3 and 4 feet thick. A little above the large coal seam occurs the lower edge of a great bed of sandstone, which has here a thickness of nearly 100 feet.

A mile east of Blairsville, the strata dip gently to the S. E., beyond which the inclination becomes imperceptible, and at Christopher Hill's they plainly dip to the N. W. The removal, or denudation of the upper strata in this neighborhood, has been just sufficient to render the ore bed in F. XI. accessible over a considerable space.

The Fourth or Toby's Creek basin.

Five miles N. W. of Bennett's branch, ranges the summit of the high ridge, designated on the map of the State as the Elk mountain. Its elevation above the stream is not far short of six hundred feet. The sandstone and conglomerate rocks, constituting F. XII., here reach the surface and form a rough and stony belt, nearly four miles wide. The rise of the strata on the N. W. side of the Bennett's branch basin is tolerably rapid. About half way across the broad anticlinal elevation of Boon's or Elk mountain, occurs a considerable exposure of red soil, derived either from the red shale and iron ore stratum of F. XI., or from the upper layers of F. IX., which latter formation, however, it can hardly be.

Crossing this broad ridge to the N. W., we enter the coal measures of the Toby's creek basin, the centre of which lies above five miles south of the turnpike, on a branch of Little Toby creek known as the Brandy Camp creek. The coal measures extend from the turnpike at the sources of Little Toby and Brandy Camp streams, to near the summit of Boon's or Elk mountain on the S. E. The conglomerate, F. XII., shows itself on the N. W. side of the ridge, a few rods from the turnpike, at a point about a mile west of the Jefferson county line, and presents a bold wall of rock more than twenty feet high. But a small part of this stratum is conglomeritic, the chief portion being a coarse yellowish sandstone, marked with ferruginous streaks. At the upper edge of the stratum is a layer of compact, white, siliceous sandstone. The stratum ranges north from this locality, which is near the source of the south branch of the Elk creek, across to the head of the north branch of the same stream, cropping out a little below the highest summits. The engineers who have surveyed this neighborhood, mention this rock as occuring at their summit, between the sources of Elk creek and West creek, which runs into the Driftwood. In its course to the S. W. the stratum twice crosses the Clarion, entering the tops of the hills at the mouth of Little Toby, and again a mile and a half above, from which line it spreads back four miles south-eastward, towards the Kersey settlement, on Brandy Camp creek, near the summit. On the Clarion river, one mile below the mouth of Little Toby creek, and about twenty rods above that of Bear creek, (Beaver creek on the map,) there occurs on the east side of the river a fine deposite of bog ore. The rocks of F. XII. descending, here occupy the middle third of the hill, and form a stratum at least 100 feet in thickness. Five or six springs, in a space of about thirty rods, issue along the lower edge of this rock, each of them depositing of the pulpy red oxide of iron along the slope leading down to the river. Probably twenty acres are covered with the deposite, the average depth of which may be given at seven feet. The coarse conglomeritic sandstone F. XII. is not exposed, but the more flaggy beds of F. X. show themselves at the base of the hills, where the contact of the two formations is clearly marked by an abrupt change of slope at the level of the springs. Huge blocks or masses of the overlying rock have detached themselves from the body of the stratum along the face of the hills. Though partly conglomeritic, the largest pebbles rarely exceed in size a hazel nut. The hills rise about one hundred feet higher than the upper edge of the conglomerate, and about half way in this interval, or about fifty feet below the summit, occurs an indentation or bench which may possibly imply the existence of a seam of coal here.

Several sections of the strata in different parts of the basin were obtained, some of them embracing an almost complete series of the rocks and included minerals. In these researches we ascertained the existence and position of two valuable beds of limestone, which we believe to be continuous over a considerable space of country, together with another middle band found to be destitute of fossils, and the continuity of which we consider doubtful. The sections are compiled from observations, made in one case on the east side of Brandy Camp creek, about five miles south of the turnpike; in another instance at a point nearly opposite, on the west side of the same stream; and in a third at Kyler's situated near the head of Little Toby. Some of the results included in the sections were procured near the head of Brandy Camp creek, at Mr. Thompson's, and on Limestone run, which enters Little Toby four miles below Jesse Kyler's. A large deposite of red bog ore occurs adjacent to the conglomerate and seems to be connected with filtration through the body either of this rock or of one of the ferruginous sandstones above it. Though no satisfactory exposures of F. XII. were here seen near the level of the ore, the stratum was detected in the bed of the stream, at a somewhat lower level, one mile lower down the Brandy Camp, and twenty rods beyond was seen a bed of limestone in the edge of the creek and over it about forty feet of dark colored shale. This shale, in other localities, was discovered to abound in kidney ore, and the deposite in question might by some be referred to it, but I more incline to attribute it to the sources above referred it. The deposite of ore occurs on Mr. Thompson's land, near the head of the Brandy Camp. It covers in all an extent of perhaps ten acres, and was proved to be in one place seven feet deep, though its average depth is believed to be not so much. The upper edge of F. XII. seems here to be below the level of the stream; but twenty-five feet higher up e beds of shale, containing large masses of rather coarse nodular iron ore, and at an elevation of about seventy-five feet is a seam of coal, from 3 to 4 feet thick, the upper part of which is cannel coal. About twenty-five feet still higher in the series, lies a bed of limestone characterized by small univalve fossil shells. Indications of a still higher seam of coal occur in the channel of the run above this limestone. Directly under the coal below the limestone, is a layer of excellent fire clay. The land here is owned by a Boston company, who possess some good tracts of ore and coal land in this region. The position of these beds in the series will be readily seen from the section to be presently given. The lower limestone near the conglomerate was met with again between five and six miles to the S. S. E. on Limestone run, which enters Little Toby about that distance south of the turnpike, and heads three miles still further southward. The rock here is of a lighter color, but it contains the same fossil shells and encrinites. This bed was found by one of our party 6 feet thick on an adjacent run, accompanied by a trace of coal directly beneath it supported by a layer of fire clay, containing balls of iron ore. This is about its thickness on Limestone run, where almost immediately below it, lies the upper edge of a bed of sandstone just visible, with many embedded impressions of fossil plants. This stratum was supposed to lie not far above the conglomerate. About fifteen feet over the limestone is a shale abounding in iron ore, the lumps of which are numerous in the channel of the run. It is of various qualities but promises well as far as quantity is concerned.

Signs of coal occur here evidently dislodged from some higher level, but the outcrop of none of the higher strata could be detected. The hill ought to contain, we conceive, at least three seams of coal; but its position, it should be observed, is on the southern margin of the coal measures. The soil of the adjacent country is decidedly good, and we have shown that the region is far from deficient in mineral treasures. The day must come, therefore, when it will sustain a considerable population. The hills are by no means high, rarely more than three hundred feet. Pine timber is abundant and our commoner hard woods attain a very large size. The settlers at present are very thinly scattered.

In collecting the results of the following sections, our practice was to open the outcrop of all the more important beds sufficiently to ascertain their exact thickness by measurement. While obtaining materials for the last, we were much assisted by Mr. Jesse Kyler, from whom we derived much valuable information.

Section of the strata near Horton's, E. side of Brandy Camp creek.

Olive shale.	
Coal, slaty,	2 feet 6 inches.
Bluish sandstone,	20 “
Black slate,	2
Coal, of good quality,	2 “ 8 “
Grey sandstone,	15 to 20 “
Bluish grey sandstone,	10 “
Interval of a few feet, supposed to contain a limestone,	
Olive shale, more than	5 feet.
Dark sandstone,	7 “
Coal, the slaty cannel coal variety,	1 “
Black slate,	1 “
Bluish shale, containing ore,	8 “
Greyish sandstone, more than	20 “
Interval of a few feet, supposed to contain a limestone.	
Coal, of good quality,	2 feet 6 “
Fire clay,	6 “
Bluish shale, abounding in kidney iron ore.	
Interval of about 30 feet, supposed to contain a limestone,	30 “
Sandstone, more than	2 “

The abundance of iron ore in the bluish shale near the bottom of the section, and a comparison of the several beds with those found on Limestone run already described, lead to the inference that the interval of thirty feet immediately below, must contain the lower limestone of the section following.

Section of the strata in the hill on the west side of Brandy Camp creek, opposite Horton's.

Olive shale.	
Coal, of good quality,	2 feet.
Fire clay, good.	
Sandstone,	20 “
Olive shale,	6 “
Coal, cannel coal,	1 “ 6 inches.
Black slate,	12 “
Sandy shale,	2 “

Black slate,	1	feet.	
Sandy fire clay,	3	"	
Compact blue limestone,	4	"	
Sandy olive shale,	20	"	
Black shale; here ought to be a bed of coal, which is probably thinned out,	2	"	
Blue shale,	25	"	
Blue limestone,	4	"	
Olive shale,	5	"	
Black slate,	2	"	
Coal,	2	"	6 inches.

The bottom of this section are the lowest exposed beds near the level of the creek.

Section of the strata at Kyler's, one mile south of the turnpike, head of Little Toby.

Coal.			
Strata undetermined,	25	feet.	
Brownish, olive shale.			
Sandstone,	6	"	
Coal.			
Stratum undetermined,	10	"	
Olive shale, more than	6	"	
Conglomeritic sandstone, dark colored and somewhat calcareous,	3	"	
Blue sandy shale,	18	"	
Compact limestone,	3	"	
Olive shale, upper part a compact whetstone,	8	"	
Sandstone, thin bedded and micaceous, of a blue and grey color,	15	"	
Blue shale, containing nodules of sulphuret of iron,	4	"	
Coal,	4	"	
Fire clay.			
Brown shale, containing iron ore,	5	"	
Black slate, from	15 to 20	"	
Coal, of good quality,	3	"	6 inches.
Fire clay, sandy.			
Sandstone.			

The lowest of the blue limestones of the second section being discovered nowhere else, and being somewhat sandy, we have supposed it might disappear by degenerating into a calcareous sandstone. The coal seams vary considerably in thickness and quality, showing a transition from glance to slaty cannel coal, or bituminous slates. The second coal ascending, recorded in the first and third sections, appears to have thinned away in the locality of the second section. It may possibly have escaped notice in the stratum marked black shale, as slaty cannel coal, of which it consists where the first section refers, much resembles at its outcrop a black coal slate. None of these coal seams have been worked, nor has any use yet been made in this neighborhood of either the coal, iron ore or limestone, so accessible in the hills. The shales and sandstones, it will be observed, graduate into each other without regularity. The first bed of limestone ascending in the series, contains a small univalve shell, somewhat like a nautilus, which being easily distinguishable from the fossils of the upper and lower limestones, may serve as a feature by which to recognize the stratum. No bed of iron ore was discovered as promising as that in the lower bed of shale, though less abundant exhibitions of ore are not unfrequent in other members of the series.

The neighborhood where the foregoing sections were obtained, is about eight miles from the Clarion river. The country around possesses a pretty good soil, and the surface is such as to admit of the construction of good roads.

Of the coal measures along the line of the Portage Railroad.

The examination of the coal measures bordering the Portage railroad, has led to tolerably definite results respecting the structure and contents of this part of the bituminous coal region. The numerous artificial exposures of the strata have proved of great assistance in identifying and tracing the several mineral beds, but a full and detailed account of the stratification cannot be presented until a series of sections can be published. The form of the Allegheny mountain is that of an elevated table land, bounded by an abrupt slope to the S. E., and descending more gradually to the N. W. The almost level top of the mountain in Cambria county, has an average elevation above the eastern base of about fourteen hundred feet, while the width of the actual summit varies from one to two miles. It is intersected at frequent intervals along its eastern escarpment by long and deep ravines, which mark the passage of the mighty flood that has stripped its summit of all the softer and more destructible strata. Around the heads of these transverse valleys, the width of the table land is contracted, and the real summit of the waters thrown westward of the general front or escarpment of the mountain. In this part of the State the mountain is capped by the massive sandstones and conglomerates of F. XII. In the neighborhood of the Portage railroad, where the mountain is cut by the deep gorge of Blair's gap, the summit level is not attained till we are nearly three miles west of the main front of the mountain. This causes an outcrop of the upper rocks, including the coal, to the eastward of what at first seems the summit, while it is in fact to the westward of the actual crest of the mountain.

Along the line of the railroad, seams of coal have been discovered, and are worked in many places, though we have ascertained the whole number of workable beds to be but four; of these beds, which we will designate in the ascending order by the letters of the alphabet, the first or lowest which we shall therefore call A, shows itself near the foot of plane No. 6, where it is six feet thick, and lies between thirty and forty feet above the sandstone, F. XII. It is here mined to some extent by Dr. Shoenberger. This bed again appears between Croyle's mills and the viaduct; also about half a mile west of plane No. 1, and again on the Conemaugh, three-quarters of a mile east of Johnstown, where it is 4 feet thick, and likewise at the Red bridge, six miles up Stoney creek, where its thickness is 3 feet and 9 inches. Though generally the lowermost coal bed in the formation, we have in two places met with a small irregular seam, about thirty feet beneath it in the series, and very near the upper surface of F. XII.

The second coal seam, B, is mined at Croyle's mills, at the tunnel bend, and at Johnstown. It has everywhere immediately beneath it either a single or double band of limestone, of a thickness varying from 3 to 10 feet. A part of this limestone furnishes at Johnstown, a good hydraulic cement. The average thickness of the coal seam is 3 feet, and it is separated from the coal bed beneath it by from 50 to 80 feet of strata. The outcrop of this bed is visible on plane No. 6, but the seam appearing thin, it has not hitherto been opened, though its true thickness may be greater than the outcrop shows.

The next coal bed of importance ascending, D of the section, shows an outcrop a little below the head of Plane No. 6, and is now mined with some activity by Mr. Lemon, a little west of this on the railroad. At this place it is 4 feet thick, while on all the levels west of the summit, its average thickness is about 5 feet. It preserves very uniformly a distance of 60 feet above the second seam B. Besides occurring in many places along the line of the Portage railroad, it shows itself in the hills around Johnstown, and all along Stoney creek, for seven miles and more above its mouth. On the creek it is found to vary from 2 to 4 feet in thickness.

The uppermost of these four important coal seams, E, though tolerably constant in its thickness, which is from 3 to 4 feet, is irregular in its distance from the bed below it. At the summit, it is separated from Lemon's seam by about 140 feet of other strata, at Croyle's mill by 110 feet, and at Johnstown, by only 44 feet.

Along the valley of the Conemaugh and its tributaries, two other coal beds are indicated by the benches or indentations in the surface, whenever the hills are of sufficient height. The lowest of these beds lies about 200 feet above the fourth of the previous enumeration, and was in one place proved to be a foot and a half thick. Neither of them has been found hitherto sufficiently thick to be valuable.

In this part of the country, the third coal seam, C, to be seen in the engraved sections, does not appear in any considerable thickness, though it is represented probably by a thin band never over 9 inches thick, found in a number of places in a position between B and D.

Three bands of limestone are associated with the several coal seams above described; the first, or lowest, has been mentioned as underlying the second coal bed B of the series; the second bed of limestone was observed at Croyle's mills on the Conemaugh, and at the red bridge on Stoney creek, five miles above Johnstown, varying in thickness from 3 to 6 feet. Its relation in position to the coal beds of the series at each place is obscure, underlying a coal bed which is supposed to be the bed D, though that bed is accompanied by limestone at no other locality. This has been measured in three localities, two of which are on Stoney creek. The third bed of limestone has been ascertained to be in one place 3 feet thick, and sixty feet above the coal bed D, and in another neighborhood (on Stoney creek) 2½ feet thick, and twenty-nine feet above the coal.

Iron Ores.

Indications of iron ore occur in the red shale, F. XI., on the eastern side of the mountain, in Burgoon's gap, where there is a large spring depositing bog ore. Loose pieces of ore accompany the same formation near the head of Plane No. 7, where some unsuccessful diggings were made by us. A similar spring, occupying a corresponding position to that at Burgoon's gap, is said to exist three miles south of the railroad. Though various localities bordering on the line of the railroad were explored for ore, but two places were met with worthy of description for the amount of ore developed, and both of these need further investigation before their value can be positively ascertained. One of these is on the level between Planes No. 3 and No. 4, where there occurs a bed of soft shale 5 feet in thickness, apparently one-fourth of which consists of ore. Its position in relation to the accompanying strata is shown in the following *section:*

Dark friable shale,	20 feet.	
Coal,		6 inches.
Black slate,	1 "	6 "
Sandstone, hard and ferruginous,	1 "	6 "
Friable shale, nearly one-fourth ore,	5 "	
Slates and flaggy sandstones,	20 "	

At the head of plane No. 3, a mile from this, the ore-bearing band is replaced by 5 feet of limestone, probably the third limestone of our previous enumeration. Such replacements of ore and limestone are by no means of rare occurrence. The next locality displaying a somewhat promising amount of ore, is on Stoney creek, about half a mile below the red bridge. Here, at an elevation of eighty feet, in a steep bank on the north side of the stream, we find numerous nodules of good ore closely bedded together in a stratum, 1 foot thick. Directly under this is a ferruginous limestone, in nodular masses, the whole 2½ feet thick, and this is followed by 2½ feet of fire clay. Lower in the series about thirty feet, we find a bed of coal, B, 4 feet thick, underlaid by 6 feet of limestone, and after a space of ten feet below this again, occurs a mass of shale, one layer of which, 1 foot in thickness, presents a total thickness of 5½ inches of good ore, traced by us one hundred yards along the foot of the hill.

The Coal Basins south of the Conemaugh.

Leaving the vicinity of the Portage railroad and Johnstown, and directing our attention in the next place to the country between the waters of the Conemaugh and the southern line of the state, I shall notice first the characters and position of two great anticlinal axes, the knowledge of which is essential to a correct understanding of the region. The first axis of elevation, going westward, in the latitude of the Portage railroad, is finely exposed at the viaduct, eight miles E. of Johnstown. At this place the strata have been sufficiently lifted to bring into view the red and variegated shales of F. XI. A spectator looking westward from the summit of the Allegheny mountain, at the head waters of Shade creek, may trace the course of this axis by a broad ridge or line of highlands, stretching to the S. S. W. towards Jennerville. It is difficult to settle exactly the point at which this axis flattens away, but it is observed at the mouth of Roaring run on the Quemahoning, and on Stoney creek below the mouth of Paint creek. This line of upraised strata, and the axis of Negro mountain, traversing Somerset county, are unquestionably the primary cause of the scarcity of the coal measures around the town of Somerset and along the eastern base of Laurel hill. From the same station on the Allegheny mountain, a spectator sees between him and the ridge above mentioned, a rather larger and better defined range of high land running parallel with the first. This owes its elevation to a second anticlinal axis which crosses Shade creek, between Huskin's run and Roaring fork, passes then between two and three miles east of Stoystown, and ranges east of Somerset, through the middle of the Negro mountain, which commences here as a broad and regular ridge, running to the S. S. W. Near the southern line of the state, the Negro mountain separates into two slowly diverging crests, caused by the gradual rising towards the south of its axis of elevation, bringing the easily denuded red shale of F. XI. to the surface, as may be seen where the National road crosses it. This axis could not be definitely traced northward of Shade creek, though observations made at the forks of Paint creek render it highly probable that it ranges far into the wild district between Shade creek and the Portage railroad. Should it maintain its usual straight course in this direction, it would coalesce with the Allegheny mountain in the neighborhood of the railroad summit.

From Johnstown to Somerset, the rocks which saddle or overlie these axes appertain exclusively to the coal measures, except in the bottoms of the ravines where the underlying strata disclose themselves. The western axis subsiding to the south, and the other declining as steadily towards the north, they embrace between them, where they pass each other, the narrow basin of Stoystown. Here a moderately perfect section of the rocks was procured, from which we find a very similar series of strata to that observed along the Conemaugh.

In this narrow central basin of the county, the coal bed A has been developed in many places along Little's run, four miles north of Stoystown. The bed here contains 5 feet of good coal. Separated from this by 100 feet of strata, we find the next overlying coal bed, B, here 2½ feet thick, and resting immediately on its attendant layer of limestone, from 3 to 4 feet thick. The place where this appears is two and a half miles north of Stoystown, at Lohr's limestone quarry.

The coal bed C is worked by Mr. Kimmel, at Stoystown, where it is 4 feet thick, and overlies the last at an interval estimated to be from forty to fifty feet. The identity of the bed at Kimmel's with that at Lemon's on the Portage railroad, established by a comparison of the stratification, is borne out by a similarity in the character of the seams themselves.

The coal seam E seems to be divided, in the vicinity of Stoystown, into two beds eight feet apart, and each of them 3 feet thick. The lowest of these is worked by Messrs. Cooper and Graef, on a little branch of Oven or Breastwork run, about two miles N. E. of Stoystown.

There is an outcrop of apparently a large coal seam on the turnpike, east of Stoystown, overlying the uppermost of these beds, at a distance of about ninety feet. Benches or indentations on the surface indicate the existence of two or three other coal beds between this and the summit of the highest hills, though the localities where the coal has been opened are so scattered and few as to interfere with all attempts at placing them accurately in the series.

Comparing the order of succession of these beds at Stoystown with the series which presents itself on the Conemaugh, we perceive:

First, that a small quantity of iron ore reposing upon coal A, at the railroad summit, and near Croyle's Mills, becomes in the vicinity of Stoystown, a regularly formed band of nodular ore. This is evident from fragments seen in the bed of the small creek on which Little's coal bed is opened.

Secondly, that a band of sandstone seen over the same coal bed at Plane No. 1, and at Stoney creek bridge, appears in corresponding place over Little's coal.

Thirdly, that the small coal bed found near Johnstown, above the same seam, is represented by two small beds seen under the limestone which attends the coal B, three miles north of Stoystown.

Fourthly, that the same bed of limestone accompanies coal B in both localities.

Fifthly, that the sandstone over the coal bed B retains not only its relative position, but its average thickness, about 30 feet, and also its characteristic features in both districts.

It would seem that all these strata in the small Stoystown basin gradually rise as they pass south lifted, in all probability by the widening and rising of the Negro mountain. This elevation of the whole basin is made evident at Somerset, by the paucity of the coal in that neighborhood, the bottom strata of the coal measures having been there brought up to the level of the lower streams, and many of the superincumbent beds having been removed by denudation.

All traces of the viaduct axis disappearing in the neighborhood of Jennerville, we have from Somerset southward, but one wide basin between Negro mountain on the east and Laurel hill on the west.—The synclinal axis or line of meeting of the western and eastern dips is far from ranging centrally through this basin. Its course is immediately along the base of Laurel hill, coinciding very nearly with Laurel hill creek, which like so many other streams, flows along the line of the axis, while its distance, on the other hand, from the western foot of Negro mountain, is between five and six miles. Contrary therefore to the general rule, the western or north-western dips in this basin are much gentler than the south-eastern. Inasmuch as the whole body of the coal measures in the deeper part of the basin, affords but 4 or 5 seams of coal, and these of deteriorated thickness, it is obvious that in the vicinity of Somerset, so near the eastern margin of the trough, the conglomerates and sandstones of F. XII must approach very near the surface. These rocks show themselves, indeed, on the western flank of the Negro mountain.

Iron ores of the Stoystown basin.

Before quitting the details of stratification in the Stoystown basin, we must make a brief reference to its iron ores, respecting which there is but little to say. A small band of ore near Somerset, and another 5 inches thick, occurring under Cooper's coal vein, are the only deposits visible. There are, however, important localities on

Shade creek, Paint creek, and Wells' creek, within the same general district, but not strictly within this basin which may be noticed in this place.

Although the old Shade furnace was supplied with a poor ore, which led to its abandonment, there occurs an abundant deposit of pretty good ore, recently discovered two miles further up the stream. It is in coarse nodules, some of which are of great size, though a small layer of a finer quality, and a few inches thick overlies it in a compact shale at a distance of four or five feet. Between ten and fifteen feet above this latter layer, there is a thin seam of coal about 16 inches thick. No other coal bed, and unfortunately no limestone, has yet been, or is likely to be discovered in this immediate neighborhood. Notwithstanding the scarcity of these materials, the spot seems a sufficiently favorable one for the manufacture of iron, the ore seeming to be good and abundant, and fuel, both charcoal and mineral coal, being procurable at no great distance. A small furnace is therefore now erecting at this place. The geological situation of this ore is in shale, resting directly on the upper surface of the coarse conglomerate F. XII. Indications of the same ore occur in a corresponding position, the whole way from the old Shade furnace to the mouth of Shade creek.

At Lambert's mill there is a bed of coal 3 feet 7 inches thick, and over it 12 feet of dark shale, containing a yellowish fine grained ore, in flattened nodules, weighing from ten to twenty pounds. The aggregate thickness of the ore, in the whole 12 feet of shale, is estimated at 2 feet. Ten or twelve feet beneath the coal bed, lies a band of limestone, in thickness about 2 feet.

The promises of ore at the forks of Paint creek are still more flattering. There is likewise good coal, and a band of limestone and excellent water power at this place. The hill between the two streams which unite at the Falls of Paint creek, exposes especially on its northern side, a bed of shale and sandstone, between 20 and 30 feet thick, resting on a seam of coal 3 feet in thickness. In this shale are many layers of nodular iron ore. The lower bands are generally thin and flaggy, the rounder nodules being confined to the upper part. The aggregate thickness of the ore at this place was estimated at 2½ feet; but it is not probable that it maintains this abundance over a wide space, as this species of ore is never very uniform. Lower down the main stream occur two other layers of ore, referable apparently to the upper beds of F. XII. One of these is a band 7 inches thick, of excellent ore; the other is coarser and 8 inches thick.

A fourth locality, important for its iron ore, is on Wells' creek, five and a half miles N. E. of Somerset. Here a layer of limestone occurs in the bed of the creek, resting on a blue sandstone, which forms the bottom of the channel. The limestone is said to be in all 6 feet thick, though only two feet are exposed. A coal bed showing a promising outcrop, appears a few feet above the limestone, and indications of other coal seams present themselves further up the hill. One of these upper beds has been worked. At the top of the hill, nearly three hundred feet above the stream, in a sterile tract of a few acres, many pieces of a very rich red ore have been met with, but the quantity remains unknown. This spot deserves examination on the part of the owner, Alexander Hunter. Should the ore be abundant, its value would be enhanced by its proximity to another deposit of ore on Stoney creek, with which it might be worked. A furnace is much wanted in this section of the country, while charcoal and water power are both plenty.

The ore just referred to on Stoney creek, is at the "Silver diggings," about two miles above the mouth of Wells' creek. Here a shaft twenty-eight feet deep was found, which passed through two bands of ore, the lowest of which lying lower than the bed of the creek, cannot be worked. The upper, though a small seam, consists of very pure ore. This is of insufficient thickness by itself, but at the upper edge of the shaft there is another layer of ball ore, apparently of ample size, possessing an aggregate of ore equal, we think, to one foot.

Quitting now the middle or Stoystown basin, and directing our notice to the larger parallel trough on the S. E., or that which lies between the axis of Negro mountain and the ridge of the Allegheny, we have to remark that this basin in all probability takes its origin on the table land of the Allegheny, south of the summit of the Portage railroad. Owing to the wilderness state of the country for some miles south of the railroad, and the extreme paucity of exposures, very little could be accomplished in developing its geology. This tract, as far south as the line of Somerset county, has the character of a barren table land. The first neighborhood important for its mineral deposits which we meet with in passing south, is that on Shade creek already described. The localities here, though appertaining properly to this basin, and not to that of Stoystown, were referred to in another connection for the sake of describing all the iron ores of the neighborhood under one general head. The anticlinal axis, separating the two basins, is first obviously recognized on Shade creek between Huskin's run and Roaring fork, where the red and green shales of F. XI. are plainly brought into view in the banks of the stream. From "Miller's breast works," the whole way to Shanksville, and along the Stoystown turnpike, we can generally trace four benches in the hills indicative of as many coal seams. Three of these are plainly visible around Shanksville, though the coal has not been opened. This little village is on *Stoney creek*, two miles further east than the position given it by the State map.

Along the Allegheny mountain, following the eastern outcrop of red shale F. XI., the ore of this formation was recognized in many places from Conover's fork of Shade creek, the whole way to the Maryland State line. It is well marked by the springs depositing bog ore, which so generally issue from this stratum. The appearances at Conover's fork, indicate sufficiently the general character and relations of the deposit throughout its range.

Ascending the mountain from the west towards the head of the stream, the lowest bed of coal, A, is seen cropping out within two and a half miles of the summit, succeeded by the rocks of F. XII. rising a little faster than the surface. East of the outcrop of F. XII. which is not wide, the softer red strata of F. XI. appear and form an extensive smooth flat. This terrace of the red shales, notwithstanding its elevation, generally affords a good arable soil. It varies in breadth, and is sometimes bounded on the east by outlying patches of the harder rocks of F. XII. in the form of knobs. At the western base of these knobs, a gentle westerly dip of the rocks throws out on the surface of the red shale, a line of copious springs charged with ferruginous matter. These springs flowing from the ore layers near the top of the red shale, deposite the oxide of iron in the form of bog ores, in deep circular beds.

At Conover's fork, the line of the springs is a mile west of the summit, the red shale appearing around them. The overlying beds of F. XII. are here about fifty feet thick. Though the existence of a band of solid ore, in the upper layers of the red shale, is only inferred from the circumstance of these ore springs, the appearances are such, that diggings should be made along the margin of F. XII., where the escarpment of this rock begins. The hard ore may perhaps occur in places so near the surface, in some parts of the flat, as to be accessible by merely uncovering or stripping. This is the state of things on Laurel hill, at Garey's.

The strata in the Allegheny mountain generally dip to the westward, at an angle varying from 15° to 20° causing the overlaying coal measures to ascend the western slope to within a mile and a half of the eastern crest. But where deep valleys of denudation intersect the mountain obliquely on its eastern escarpment, the coal is made to appear occasionally as if it outcropped *east* of the main summit of the ridge, though its true position is still westward of the general crest.

Transferring our attention now to a more southern portion of the eastern basin, (that of Berlin and Salisbury,) we perceive that the coal measures along Castleman's river between Salisbury and the mouth of Flaugherty's run, are confined almost entirely to the hills on the western side of the river, the rocks of the eastern bank, though at the west foot of the Allegheny mountain, being chiefly the sandstones and conglomerate beds of F. XII. The steepness of the western dip along this part of the eastern side of the basin will explain two features of some importance. One of these is the position of the synclinal axis or bottom of the trough, which lies considerably east of the centre of the valley; the other is the greater thickness of the coal measures in this vicinity compared with the tracts further north. We consequently discover here the large bed of coal, high up in the series, which, from the shallowness of the basin elsewhere, has not been preserved from denudation. This coal lies near the top of a long hill between Castleman's river and Elk Lick creek. The Negro mountain axis, which lifts to the surface, in Maryland, formations as low in the series as F. IX., subsiding to the north and the synclinal axis of the basin rising, the trough of the coal measures becomes gradually shallower in this direction. One consequence of this rising of the bottom of the basin northward is the disappearance of the large coal seam at Castleman's river.

An opportunity for comparing the relative thickness of the strata lying above and below the water level in the centre of the basin, is furnished by a salt boring on Elk Lick creek, three miles above its mouth. There appear to be about 400 feet of coal rocks below, and nearly the same amount above the level of the stream; though the relative number and thickness of the included coal seams is different, for while only three beds of any note, having an aggregate thickness of 10 feet, were noticed between the bottom of the boring and the water level, there are no less than seven beds, though some of them thin ones, amounting to 20 feet of coal, in the strata between the water level and the tops of the hills.

By comparing these beds first with the series along Castleman's river, in the next basin to be described, and then with those on the Conemaugh and in the Ligonier valley severally, we find a progressive dimunition of the intervals which separate corresponding coal beds as we proceed from the S. E. towards the N. W. We also find, as far as these basins are concerned, an improvement in the number of the workable beds in the same direction. Notwithstanding these changes, we notice a remarkable permanency, both in the number of the coal seams and in their accompanying layers of limestone and iron ore. Thus, the lowest coal seam, designated A on the engraved section which accompanies this report, is in the eastern or Berlin basin 3 feet thick, and overlaid by 100 feet of sandstone. The ore immediately above it, on the Conemaugh, is absent in the neighborhood of Castleman's river. The next bed of coal, B, rests everywhere directly upon a layer of limestone, each of these being in this place 5 feet thick.

A seam of coal holding a corresponding position in the series, occurs at the winding falls of Elk Lick, on the side of the Negro mountain. Here the usually accompanying limestone is not seen. We generally find beneath this coal and limestone a massive stratum of sandstone. This causes the falls of Elk Lick, where the coal consists of two beds, the uppermost 2 feet, the undermost 2 feet 3 inches thick, separated by 1 foot 6 inches of fire clay. The whole reposes immediately upon 5 or 6 feet of fire clay, and this again upon the thick mass of sandstone.

The falls of Elk Lick is a succession of many small and rapid leaps, winding in a long descent through a narrow irregular channel in the sandstone; the rocky walls sometimes overhang the stream, which is then darkened by the meeting boughs of the trees and the tangled stems of the laurel, which in many places make an almost impenetrable thicket. The defile itself is alternately contracted into short narrow passages and widened into more spacious chambers. The whole scene, though of limited extent, is striking for its novel and picturesque beauty, and in perfect keeping with the wilderness around. The water power at this spot derives value from the discovery of a bed of iron ore to be mentioned presently.

The third coal of importance, (E of the section,) is between 2 and 3 feet thick. It is a rather poor coal, and like the former, reposes upon a bed of limestone 5 feet thick. They show themselves near the level of the stream, at the old salt boring on Elk Lick. Between the two coal seams, B and E, occur two other smaller beds, C and D, along the edges of the basin. These correspond with beds in the Ligonier valley, and on the Conemaugh.

The next bed in the ascending order, F, is here 4 feet thick and of good quality. It is accompanied by three insignificant seams, the overlying one being 2 inches thick, while the uppermost of the inferior ones is 12 inches. Elsewhere, in the other basins to the N. W., it assumes a more trivial thickness. The coal bed G, also a widely diffused stratum, measures 1 foot 6 inches in thickness.

Still rising in the series, we find another, though a very thin coal bed, H, said to be 1 foot thick. This bed becomes 3 feet thick in the basin between Laurel hill and Chesnut ridge. Still ascending the hill, on the east side of Elk Lick creek, which has furnished us with all the details of the foregoing section, from E upward, we meet with the great bed, I, 9 feet in thickness. Indications of this appear in other localities near the Maryland line. The same stratum occurs in the series at Ligonier, where it is underlaid at a distance of twenty feet, by a bed of limestone measuring 6 feet; this limestone has not been yet detected on Elk Lick. Though sufficient progress has not yet been made in our researches, to enable us to compare with any certainty, the stratification of the great coal field west of Chesnut ridge, with that of the basins we are now describing, a sufficiency of evidence exists to render it highly probable, that the great coal seam before us, is identical with the widely diffused valuable coal bed so well exposed at Pittsburg.

Two other coals, K and L, are indicated by their smut, the lower evidently a large bed.

Limestone beds.

With regard to the limestones, three distinct layers occur along the centre of the basin. The uppermost caps the hill which contains the large coal seam between Elk Lick creek and the river. The quality of the rock is good, but its thickness, owing to denudation, could not be ascertained. The second descending, is a foot and a half thick, and overlies the thin coal bed, H. The third is seen in many places along the level of the creek. It dips beneath the stream at the salt boring; and half a mile further down the creek, it has been opened at an elevation of fifty feet above the level of the creek.

This difference of level, attributable simply to the inclination of the strata, led us at first to suppose that there were here two separate beds of limestone, but this proved to be an error. The thickness of the bed is 5 feet, its quality is good. The limestone, we have already stated, supports the coal seam E.

Upon Castleman's river, at the mouth of Buffalo Lick creek, there is a fourth layer of limestone, not noted in the salt boring. As more or less uncertainty attaches to all results derived from narrow perforations of the strata, like these borings for salt, the absence of this bed in the well in question, may be only apparent. This limestone at the mouth of Buffalo Lick creek, where it is 5 feet in thickness, supports the coal bed B.

While tracing the limestone beds of this basin, it was a problem of some interest to determine, whether the rock could be sufficiently indicated by the nature of the immediately overlying soil. Viewing a peculiar orange-yellow earth as derived directly from the decomposition of the limestone, we succeeded, by adopting it as our guide, in developing two layers of the rock in the vicinity of Berlin, and pursuing them along their outcrop for a considerable distance, the soil proving in every instance, an unerring clue to the subjacent limestone.

Iron ores.

The most important deposite of iron ore hitherto brought to light in this basin, is that of the Elk Lick falls above referred to. There are here three layers of ore. The lowest, measuring 1 foot 4 inches, is a nearly solid bed, merely divided into blocks rounded at the edges. The other two overlie the first at a distance of two feet, and together contain as much ore as would be equivalent to a solid band about 4 inches thick. For the composition and quality of this ore consult the description and analysis given in the final chapter. An ore, supposed to be the same band, was discovered two miles further down the creek. Several thin seams of ore likewise occur on Tubmill run, half a mile below the saw mill, but they are not of sufficient importance to attract attention. At another place on the same stream, ore is said to have been opened in a position twenty-five feet below a coal seam, 3 feet 3 inches thick, identified with that at the falls; this ore is stated to amount to 15 inches. No indications of the iron ore of the red shale F. XI., were met with along Negro mountain; but the calcareous sandstone of that formation, is traceable throughout its whole length, being well exposed at the gap at Castleman's river, where a run descending from the south, cuts the stratum for a considerable distance.

Of the third or western Somerset basin.

The basin next to be described, is that included between the viaduct and Negro mountain axes on the east, and the axis of Laurel hill on the west. Our present purpose in this description being not so much to exhibit all the details of the geology as to offer in a concise form some of the general results of our researches, I propose to allude but casually to the localities between the Conemaugh and Jennerville, referring them to the series on the Conemaugh, and to dwell more at length upon the better developed stratification seen along Castleman's river and Laurel hill creek.

Before passing to the consideration of the coal measures of this basin, we must allude to a few localities where the rocks immediately underlying them exhibit some features of practical interest. The strata forming the eastern flank of Laurel hill, which bounds this basin on the west, consist of the sandstones and conglomerate of F. XII., while the redshales, F. XI., saddle the summit of the ridge. These latter beds likewise appear along the higher slopes of the mountain wherever the surface is gashed by deep ravines. At the foot of the mountain or western edge of the basin, the inclination of the strata rarely exceeds 5° or 7.°

Formation XI., as it appears on Laurel hill, is a series of alternating red shales and red sandstones, including a massive stratum of calcareous sandstone passing into sandy limestone, the upper surface of which is about one hundred feet below the top of the whole mass. The entire thickness of F. XI. on the Conemaugh is somewhat more than two hundred feet; this it retains as we pursue it southward, though the composition of the several members of the formation undergoes a material change. While this important and well characterized stratum retains generally, in other sections of the State, the character of an argillaceous red shale, this and the immediately adjacent belts contain a larger proportion than usual of alternating beds of compact, grey and red sandstones, which increase in relative quantity as we proceed southward. The shales becoming more siliceous, the calcareous sandstone, above mentioned, grows also more calcareous, passing in some places into an excellent limestone occasionally thirty feet thick.

The iron ore, so frequently to be met with in the upper part of this formation, is not seen on the Conemaugh, but following the belt southward along Laurel hill, we find many signs of it, as where the Johnstown and Ligonier turnpike crosses the ridge. At this point the quality of the ore is not promising, while, upon the western slope of the mountain, the limestone, which underlies it, is quarried and used to some extent. This calcareous rock shows itself likewise at the crossing of the Somerset turnpike, but unaccompanied by indications of the iron ore which ought not to appear in contact with it, but in its vicinity. It exhibits here, as in many other places, in a very remarkable degree, the action of violently and irregularly eddying currents at its formation, the often massive beds showing innumerable oblique and meeting layers that plainly mark its unequal deposition.

Still further south, on the summit of the mountain, at the head of Garey's run, the iron ore of the red shale is exposed in a very accessible manner. It occurs on a large tract, the surface of which slopes gently and uniformly to the S. E. in obedience to the general inclination of the strata, the ore band occupying the uppermost layers. This ore has been used at Fayette furnace, on Indian creek, being got by stripping and turning up the soil and superficial shale to the depth of from 1½ to 6 feet. At a spot where we caused the ore band to be exposed, it measured 8 inches in thickness and proved to be of excellent quality. It is said to have occurred in some spots as thick as 3 feet when it was worked. The line of highest land along the mountain ranges a little west of this tract. The crest consists of F. XII., a somewhat lower parallel ridge of which two miles further east, bounds the red shale tract on the lower side. In a little ravine which intersects the easternmost of these sandstone ridges appears the iron ore in large slabs, lying loose in the channel of the stream. This is on the property of Mr. John Dull, about four miles S. S. E. from Garey's. Some of the slabs of ore are 6 inches thick. Appearances here indicate the existence of two layers of the ore. A seam of excellent coal, 2 feet 6 inches thick, lies over the ore at a distance of about thirty feet. This bed probably belongs to a thin lower group of coal rocks which, in this southern section of the State, interpolate themselves as a separate formation between the upper surface of the red shale and the lower limit of F. XII. These we shall have occasion presently to describe, when treating of the corresponding part of the next western or Ligonier basin, where they are more developed. They make their appearance in the present basin at least as far north as the neighborhood of the Stoystown turnpike, where, at the head of Jones' creek, we find these carbonaceous rocks regularly interposed, with a thickness of about thirty feet between the red shale F. XI. and the sandstone F. XII. Here the enclosed coal seam is only 9 inches thick; it lies about thirty feet above the iron ore of the red shale and reposes immediately beneath the rocks of F. XII., the total thickness of which, at this place, does not exceed thirty feet.

The iron ore of F. XI. is seen near Henry Whipkey's, on the Clay turnpike, where it occurs at a small distance beneath F. XII. in several bands, one of which measures 5 inches, and another 2 inches. Here, however, more digging than we had time to bestow was requisite before we could decide the exact position and value of these layers. South of the Youghiogheny in this basin, this ore has not yet been minutely traced by us, but of its existence we have had evidence in the bog ore deposites of the springs. These are seen on the other side of the mountain, at the crossing of the Turkey Foot road over a branch of Meadow run, which descends into the basin next west.

Formation XII., along the eastern flank of Laurel hill, exhibits a variable composition and thickness. On the Conemaugh it has the character of a coarse sandstone and is nearly 200 feet thick, whereas at Jones' mill run, west of Somerset, its thickness is reduced to 30 feet, and it is underlaid, as already mentioned, by as many feet of coal rocks holding a thin band of coal. On Ben's creek, but a few miles south of the Conemaugh, it includes massive beds of siliceous conglomerate, which is indeed the true type of this formation generally throughout the State.

The formation has a thickness of 100 feet on Drake's run, a tributary of the Youghiogheny. Overlying it is a bed of coal varying from 1 to 3½ feet in thickness, separating this rock from a bed of brown sandstone. In the next basin to the west this latter stratum, approaching in character to the underlying F. XII. is readily confounded with it, the coal seam constituting the only clear line of division. This is the coal seam A, of our section. On Gabriel's run, south of the Youghiogheny, this seam is 2 feet thick, consisting of excellent coal. Here the overlying rock is no longer a brown sandstone, but a slaty micaceous sandstone, 25 feet thick.

A rude section was obtained between the forks of Ben's creek which exhibits the coal seam, B, of a thickness of 4 feet reposing upon its limestone, here 3 feet in depth; above this, sandstone and slates supporting the coal bed C, also 4 feet in thickness, and upon this again a mass of olive slate overlaid by a third coal bed referable to D, of our sections. The limestone under the coal B, is well exposed on the new turnpike connecting Johnstown and Somerset. In the short distance of a few feet, the rock passes into iron ore, its carbonate of lime being replaced by carbonate of iron. The ore is of good quality. The coal C, appears for a quarter of a mile along the road leading from the turnpike to Ligonier; the grade of the road just equalling the dip of the strata. In this thinly peopled district the exposures are few and the rocks therefore difficult to trace.

Along Roaring run, from its mouth to the bridge on the Jennerville road, a sandstone, the upper member of F. XII., fills the bed of the stream. A small exposure occurs at Griffith's mill, near the road. Descending the road from the north to the bridge, we cross the outcrop of a coal seam, which was ascertained to be the bed A, of our sections. It is mined by Mr. Bowman, two miles N. E. of the mill, where it yields three feet of rather indifferent coal. Slate and shale occur above it through a thickness of 50 feet. Covering the surface of these slates we found much iron ore of excellent quality. In the hill west of this a massive sandstone, 25 feet thick, overlies these rocks. This, following it still westward towards the middle of the basin, seems to change in character, and we are therefore deprived of any key it could afford us to the overlying coal beds. The facts collected go to show that the coal bed B, 4½ feet thick, opened by Mr. Richard two miles west of the bridge, and a band of limestone 3 feet thick underlying it, range extensively through the basin, their outcrop appearing along the streams. Above these we meet with indications of several other coal seams, the exact number and thickness of which could not be escertained. At the mouth of Lick run, on Ben's creek, is a limestone, 5 feet thick, apparently in this part of the series, the true position of which could not be settled for want of sufficient exposures. Though this may possibly be identical with the limestone under the coal B, we are disposed to view it rather as the band underlying the bed E.

Between Castleman's river and Laurel Hill creek the coal series is much thicker than in the country north of Jennerville; it is moreover better developed, from the greater height of the hills bordering the streams. Near the centre of the basin, in the vicinity of the

"Turkey foot," the coal measures have a thickness of nearly 700 feet, while further to the north the basin becomes shallower and the coal seams inferior in number and thickness. By compiling the measurements obtained in numerous places along Castleman's river and in a few diggings made on Laurel Hill creek, we have obtained a general section shewing the following to be the order of stratification, as exhibited in the engraved sheet accompanying this report.

Where the basin is deepest it contains eight beds of coal, the four lowest of which are opened in various places. These four are identical with the beds exposed on the Conemaugh.

Section at Husband's mill, Laurel Hill creek.

Sandstone.		
Coal bed D, comprising 4 feet of coal.		
Coal, tolerably good,	2 feet.	
Slate,		2 inches.
Coal,		6 "
Fire clay, good,	1 "	
Coal,	1 "	6 "
Fire clay,	2 "	
Calcareous sandstone,		6 "
Iron ore, of fair quality in large balls, in close contact,		9 "
Slaty sandstone,	7 "	
Iron ore, good,		2 "
Sandstone,	2 "	
Fire clay,	1 "	
Bluish shale,	6 "	
Coal bed, C, good,	3 "	
Strata undetermined,	40? "	
Bluish shale,	10 "	
Black slate,	3 "	
Coal bed, B,	1 "	6 "
Fire clay,	1 "	
Limestone, good,	4 "	
Slaty sandstone,	15 "	
Shale, with *iron ore* in small bands, whose aggregate thickness is sometimes 2 feet, but variable,	5 "	
Shale,	5 "	
Creek, level.		

Starting at the conglomerate and adopting as usual the ascending order, the first coal seam which we meet with is the bed A, which shows itself only along Castleman's river, near the stream. It is thickest at Schoff's bridge, where it measures 22 inches. Its distance from the subjacent conglomerate is about 30 feet, a massive sandstone separating them.

The next bed of coal, B, lies near the base of the hills. It is everywhere underlaid by its limestone. This coal is distant from the lower seam, A, about seventy feet; it is 4 feet thick on the river, (where it consists of three bands,) and 1 foot 6 inches thick on Laurel Hill creek. At the former place the limestone is 8 feet thick; at the latter only 4 feet. About 22 feet below the limestone occurs a thin seam of coal supporting a band of iron ore. This is seen on the west bank of Castleman's river, a quarter of a mile above the fording at the mouth of Zook's run, and the same band again shows itself a little above the water level on Laurel Hill creek, at the old salt boring, where in 5 feet of shale there is upwards of 1 foot of ore.

On Spring run, which empties into Castleman's river just below the great bend, below Zook's run, ore occurs in the form of slabs and balls in a mass of olive shales and sandstone, 15 feet thick. These strata lie twenty feet above the coal seam, B.

Above the coal B, about thirty feet, occurs the next seam C, at the mouth of Cox's creek. These are forty feet apart on Laurel Hill creek, and sixty feet at Turkey foot. At the former place the bed C is 2½ feet thick, and at the latter from 3 to 4 feet.

The coal bed D, was only found upon Laurel Hill creek, where, ten miles above its mouth, its outcrop is seen twenty feet above that of the bed C. Here it includes three bands, and is 4 feet thick, resting upon 11 feet of sandstone. This sandstone contains good nodular iron ore in two bands, seven feet asunder, the whole amounting to 11 inches in thickness. On Drake's run, about eight miles S. W. of this locality, there occurs a band of iron ore, at least 9 inches thick, occupying a corresponding position in the strata. Here the coal bed C is also recognized, lying at some distance below the ore and having its usual thickness of about 3 feet. A layer of iron ore, similarly situated in the series, is found at Henry Whipkey's, on the "Clay turnpike," at the foot of Laurel hill. An ore referable to the same band, was discovered in abundance on Gabriel's run, south of the Youghiogheny. A comparison of this coal seam, D, as it occurs upon Laurel Hill creek, with the bed B, on Castleman's river at the mouth of Zook's run, showing the close similarity which sometimes prevails between distinct strata, may impress a useful caution upon those who would try to identify layers merely by their internal resemblance. The seam B consists of,

Coal,	2 feet.	
Slate,		2 inches.
Coal,		6 "
Fire clay,	1 "	
Coal,	1 "	6 "

While the bed D shows these divisions:

Coal,	2 feet.	
Black slate,		8 inches.
Coal,		4 "
Black slate,	1 "	
Coal,	1 "	6 "

The coal seam E is seen, sixty feet above the bed C, opposite Phillippe's, on Castleman's river, four miles below Cox's creek. It is generally about 20 inches thick, and at Spring run, (not on the map,) reposes upon 2 feet of limestone, the stratum which usually supports it.

The coal bed F, at the same place, occurs over E, separated by about 50 feet of strata, embracing in their lower part a mass of olive colored shale, which encloses a few balls of iron ore.

The next seam, G of the section, is indicated by a conspicuous bench which encircles the tops of the highest hills. That singular natural mound called Fort Hill, is not quite high enough to receive this bed, though its sides are indented by the outcropping of the other lower seams. The distance of the bed G above F is about ninety feet, the interposed strata being in the upper part flaggy sandstone and in the lower, slates and shales, some of which, judging from the soil, are red.

A hundred feet higher in the series, lies the eighth coal bed, H, indicated by a well defined bench near the summits of the highest hills. No opportunity presented itself for determining the thickness and quality of this stratum, or for ascertaining the existence of the limestone, elsewhere found in this part of the series.

The occurrence of this seam, H, so near the tops of the highest hills, accounts for the absence of the great bed I, seen, in the Ligonier and Berlin basins, at an elvation above it averaging fifty feet.

There is a bare possibility of its existence in some of the very highest knobs in the centre of the basin. There is also a very slight hope of finding this great bed in the northern part of the basin near the Conemaugh, south of Johnstown, where, throughout a range of several miles, a conspicuous coal bench is visible in many places on the very highest land, in a position agreeing closely by measurement with that which this bed ought to occupy, adopting the Ligonier section as our standard.

In the above account of the coal seams of Somerset county we have restricted our description chiefly to the main coal formation which rests above the conglomerate and sandstones constituting F. XII. But there exists, as we have mentioned, a lesser group of coal rocks somewhat lower in the series, interposed between F. XII. and F. XI. These first assume a notable importance in this basin, immediately east of Laurel hill; but as they expand to greater thickness in the next trough to the west, that of Indian Creek valley, we shall reserve a more detailed notice of them for the close of our description of that basin.

Coal basin between Laurel hill and Chesnut ridge.

The next tract of country which demands description in our progress westward, is the well defined coal basin bounded on the east by the mountain ridge called Laurel hill and on the west by the similar chain of Chesnut ridge. These bounding mountains are broad, single, parallel and anticlinal ridges, of even summits and remarkable regularity of outline. While their crests rarely have an elevation of more than nine hundred feet above the adjoining valleys, they rest upon a base varying from three to five miles wide. They are both of anticlinal structure, a single axis of elevation traversing the whole length of each. The lowest rocks of our great secondary series uplifted to the surface at these axes are the sandstones constituting F. X. These rise to the day only near the crest of each mountain; nor do they always appear, the overlying red shale F. XI. and the sandstones F. XII. often folding over them at the summit. The red rocks of F. IX. show themselves only in the middle of the mountain at its base, where either ridge is traversed by a deep notch or mountain gap; nor do they ever rise high above the water level, but form a low arch directly at the anticlinal axis. The formation thus shows itself at the gaps of the Conemaugh and the Youghiogheny. The anticlinal structure of these ridges, combined with the gentle inclination of their strata, causes their flanks to consist in a great measure of one formation, the sandstone and conglomerate beds of F. XII., dipping nearly parallel with their slopes, and only the lower rocks of the coal series leaning against their base or rising to a moderate height along their lower acclivities. In quarters where the uplifting movement has been great with a proportionate denudation of the strata along the summit, the top of the mountain is for a considerable space almost flat, and in many instances even hallowed into a double summit by the removal of the soft shales of F. XI. giving prominence to the harder overlying sandstones of F. XII. The latter is especially the case where F. XI. possesses considerable thickness, as it does along Chesnut ridge, especially that southern half of it which bears the name of the West Laurel hill. Where F. XI. is thus developed along each brow of the mountain or immediately over its axis, the reddish iron ore near the top of the formation and the limestone in its lower part, are frequently accessible. These mountain ridges exhibit in their anticlinal axes a beautiful confirmation of that almost invariable law which I have discovered to belong to the axes of elevation, generally, of the whole Appalachian chain of the United States. The feature I allude to, is a greater steepness of the strata on the northwestern than on the southeastern side of the axis.

The coal basin of the Ligonier valley included between Laurel hill and Chesnut ridge maintains a very regular breadth of about six or seven miles throughout its entire length from the Conemaugh to the Youghiogheny river. The coal measures extend entirely across the valley, resting against the base of each mountain and rising a moderate distance up its slope. The inclination of the rocks is generally very gentle, being seldom more than 7°. The only exception to this is along the eastern edge of the valley, or rather in the lower slope of Laurel hill, where the N. W. dip, obedient to the want of symetry in the anticlinal axes above spoken of, is much steeper than elsewhere, amounting in some places, especially near the Youghiogheny, to 30°. In the central tracts the strata are nearly horizontal over a considerable breadth of the valley but being deeply trenched by the valleys of the larger streams their mineral contents are well exposed aud placed accessible to the miner.

Commencing our local details, as far as we shall attempt minute description, with the geology of the basin in the neighborhood of the Conemaugh, let us begin with the stratification in the neighborhood of Armagh and Lockport. The following section, derived from a careful examination of the beds at Lockport, will serve to represent the lower beds of the coal series as they occur, not only there, but at various other localities along the river.

Section at Lockport—Conemaugh river.

Coal, (E,) indicated by its smut and a bench.		
Sandstone, with other overlying strata,	25 feet.	
Coal, (D,)	6 "	
Strata undetermined,	20 "	
Coal, (C,)	2 feet 4 inches.	
Strata undetermined,	20 "	
Coal, (B,) of excellent quality,	2 "	
Limestone, 3 feet thick contained in a space of	10 "	
Hydraulic limestone, passing into blue shale,		8 "
Iron ore, 6 to 8 inches,		7 "
Shale, containing scattered iron ore,	12 "	
Iron ore, 4 to 6 inches,		5 "
Shale,	25 "	
Coal, (A,) comprising coal 6 inches, slate 1 foot, coal 2½ feet 4 inches.		
Sandstone.		
Rocks of F. XII., in the river bed below Lockport.		

It will be seen by the following section, procured at Centreville, that none of the lower beds of the previous section are above the levels of the streams at this place, which is near the centre of the basin. We do not pretend to introduce into this and the other accompanying sections all the strata found in the adjacent hills, deeming it best to restrict our list to those which could be definitely ascertained and measured between the water level and the limit of the good exposures, intending to complete the series by an entire section embracing the upper beds derived from explorations nearer Ligonier.

Section at Centreville.

Limestone, (under coal bed E,)	6 feet.
Strata undetermined,	20 "
Coal, (D,)	6 "

This coal lies a little below the bed of the river but appears a quarter of a mile above and a mile and a half below the village, shewing this to be the centre of the basin.

Passing still further across the basin towards its eastern side, the lower beds embraced in the Lockport section again rise from below the water level, as will be seen by a comparison of that with the following section made at Rogers' mill, near Laurel hill:

Section at Rogers's mill.

Coal, (E,)	1 feet	8 inches.
Strata undetermined, a small interval.		
Limestone,	6? "	
Strata undetermined,	20 "	
Coal, (D,) containing at Logan's 2 inches of black slate,	6 "	2 "
Strata undetermined,	20 "	
Coal, (C,) of good quality,	1 "	
Slaty sandstone,	10 "	
Coal, (B,) of good quality,	1 "	8 "

Above the coal E, occur the signs of two other beds, the uppermost being near the tops of the hills.

In the hills at Bolivar, on the western side of the basin, the strata are similar to those at Lockport, the limestone accompanying the coal seam E, being there visible in its usual position. About two miles north of Bolivar, we find the coal bed C, but instead of measuring 2 feet 4 inches, it is here 4 feet thick. The limestone of the bed E, is there likewise 4 feet thick.

East of Armagh, five miles, and one and a half north of the turnpike gate, we again find the 6 feet bed, (D,) occurring at the foot of the mountain. We here meet with indications of no less than seven beds, though only this one appears to be adapted to mining. On Finley's run, the lowest coal bed, A, shows itself and contains 3 feet of good coal. Almost immediately beneath it occur the sandstones F. XII., measuring here about fifty feet, and further down the stream appear the red shales of F. XI. The iron ore, often found near the upper limit of this last formation, was here sought for but not found. Its existence in another locality, on a hill about two miles from the run, is betrayed by a large deposite of bog ore which has been used to supply a small furnace. Guided by this deposite, the hard ore may very probably be found, and should it be present in quantity, it must be traceable to within a few rods of the furnace. The previous sections will suffice to indicate to the proprietors of land in this vicinity in what positions to search for the large coal seam, D, and the limestone above it. The deposite of bog ore, which is near the top of Laurel hill, occupies about four acres of surface, and varies in depth from 4 to 20 feet. At the bottom the ore is concreted and dark while higher up it consists of alternating hard and soft bands. Its average thickness over the four acres may be estimated at 10 feet. Within six feet of the lower edge of the outcrop of F. XII. are indications of the hard ore of F. XI. in a bench traceable for several miles, bog ore springs similar to the previous one being seen along the mountain. The outcrop of the red shale, F. XI., at the passage of the Conemaugh through Chesnut ridge, was carefully examined for ore but without success. Ross furnace, which has been in operation for more than twenty years, has recently been much straitened for ore; as springs depositing bog ore issue from the junction of the red shale and F. XII. it is possible that the hard ore may be discovered here if the clue be properly pursued. The ore bed formerly worked might be mined below its outcrop, as it undoubtedly descends with the western dip of the strata.

From the vicinity of Fairfield to a little north of Ligonier, there is a belt of country along the middle of the basin from 2½ to 3 miles wide which embraces the upper strata, the most productive in coal and limestone of the valley. The limestone is here more abundant than usual. The following section represents the stratification about two miles north of Ligonier:

Section—Ligonier Valley.

Limestone, at the summits of the hills,	7	feet.	
Strata undetermined, about	40	"	
Coal, (L,)	3	"	
Stratum unknown,	5	"	
Limestone, (e,) 6 feet thick at Keiffer's,	4	"	
Coal slate,	10	"	
Coal, (K,)	3	"	
Olive slate and soft brown shale,	20	"	
Coal, (I,) 10 feet at Keiffer's, 7 feet at Giesy's,	8	"	6 inches.
Strata unknown,	20	"	

Limestone, (d,) 4 to 9 feet,	5	feet.
Shale and sandstone,	20	"
Coal, (H,) of good quality,	3	"
Stratum unknown,	8	"
Limestone, ferruginous,	3	"
Brownish olive shale and black slate, not measured, about	15	"
Coal, (G,) smut only seen.		
Sandstone,	50	"
Olive shale,	24	"
Black slate,	6	"
Coal, (F,) not opened.		
Materials unknown, about	15	"
Coal; supposed to be one of the thin bands accompanying F elsewhere.		
Olive shale,—a little iron ore,	30	"
Coal, (E,)	1	"
Limestone, (b,)	1	"

The lowest coal and limestone of this section corresponding to the uppermost coal and limestone of the section at Lockport, we possess in the union of the two a very complete representation of the whole series of beds composing this coal basin. In the Ligonier neighborhood other lower bands were noted which I have not included in the section, as they did not admit of precise admeasurements. One of these is a coal seam 1 foot thick, corresponding probably to the bed C of other localities; another is a coal seam the representative of A, mined by Mr. Mitchell, near the foot of Chesnut ridge, where it is 5½ feet thick. At a short distance beneath this appear the sandstones of F. XII. Both of these coals, with their accompanying rocks, are far below the water level in the immediate neighborhood of Ligonier town, and emerge to the day only on the two sides of the basin.

The large coal seam, I of the section, occurs on many farms along the central part of the valley, having its eastern and western outcrops along the slopes of a range of high narrow hills occupying the middle of the trough. It varies in thickness from 7 to 10 feet. The coal is jet black, of a brilliant lustre, and comparatively free from sulphuret of iron and slate. These features, together with its position in the series, make it probable that this fine bed of coal is identical with the large Pittsburg seam, by far the most valuable member of western coal measures. This coal is of a firm texture, though it affects to a partial extent that columnar form so prevalent in many of the coal beds in the basins near the Allegheny mountain. At Giesy's it is lifted in long columnar pieces, but at Keffar's and other places it does not show this structure.

The seam A, worked by Mr. Mitchell near the foot of Chesnut ridge, after dipping under, emerges on the other side of the valley between Laughlinstown and Laurel Hill, where its outcrop is indicated by a smut immediately above the upper beds of F. XII. It is there overlaid by several other seams occupying the position of the lower beds seen in our previous sections. Thus the first above it, accompanied by a limestone, is probably the bed B, though it is here only a foot and a half thick. Next in the order ascending are two thin adjacent bands, the representatives probably of C, while higher up occurs a bed, the equivalent of D, which is here 3 feet thick, and accompanied by a considerable amount of iron ore. At Ross furnace, in the same belt of strata, but further to the north by six miles, this lowermost bed, A, was recently opened by us, and ascertained to be 4½ feet thick, though it had lain neglected, under an erroneous belief that it was of very insignificant size. Our knowledge of the stratification led us to apprehend an error in the statements given that it was only a foot or so in thickness, while the result has established the accuracy of the comparisons which suggested that this was the coal A, and that it ought to be of dimensions available for mining.

The large coal bed I, has been detected in a few places south of the Conemaugh, but it lies every where too near the tops of the hills to be profitably wrought. It was sought for in a bench near Rogers's mill, on very elevated ground, but the only trace of a coal seam discovered was a thin band five inches thick.

That part of the coal basin which lies between the Loyalhanna and the head waters of Indian creek, is comparatively illy provided with accessible coal seams. This remark applies more expressly to the central tracts of the valley which, in the country north of Ligonier, we have found to be so well supplied. The only productive portions of the district now to be described are the two strips of country bordering the edges of the basin, where the coal beds B, C, and E, of the lower part of the series rise to the surface from beneath the thick superincumbent sandstones and shales which fill the series from E to H, and which here occupy all the middle of the basin. A carefully compiled section, elaborately made from observations in a great variety of places, shows that the only valuable material included within the first or uppermost one hundred and fifty feet of strata in the central hills of the valley is a single band of limestone, about one foot and a half thick, while the only workable coal seam within the space is a high bed, probably H, near the top of a hill in the very middle of the basin. Below this barren group of rocks, but only at the sides of the valley, occur the lower coal seams and a limestone. Thus the coal bed E, the first of these descending, shows itself along the valley of Four Mile run and a little further west, immediately at the base of Chesnut ridge. It is opened at the bridge over the stream, on the Greensburg road, a mile west of Four Mile run, where it is 3 feet 1 inch thick. This bed corresponds in position with that opened by Mr. Nelson, six miles S. S. W. from Ligonier, though the latter bed is only 1 foot 1 inch in thickness. So remarkable a declension in the size of the bed in so short a distance, in this direction, is the only circumstance which suggests any doubt in respect to the identity of the coal of the two places. A band of limestone accompanies the coal at each locality. Indications of a large bed of coarse calcareous iron ore occur in immediate connexion with the limestone at the place mentioned on the Greensburg road.

On Chesnut ridge, near an old furnace on Jacob's creek, three miles S. W. of Harman's, the same coal bed, E, has been opened and shows a thickness exceeding 4 feet. A band of cannel coal, 6 inches thick, traverses the seam about eighteen inches from the roof both here and at the opening just previously mentioned, serving if other evidence were wanting, to identify the bed. Its underlying limestone and attendant iron ore were also found within four or six feet of the coal. The limestone measured 1 foot, and the kidney ore over it amounted to from 2 to 5 inches in total thickness.

The next coal seam descending is C, separated by about forty feet of sandstone from the above described bed E, and thirty-five feet below it again is the well marked stratum B. Each of the beds, B and C, is here 2 feet thick; the separating shales contain a solid band of iron ore of excellent quality, varying in thickness from 5 to 8 inches, besides a considerable amount of ore in detached flattened balls. These things occur at Harman's, up Four Mile run, above the mill which is at the crossing of the Greensburg road. The spot appears to be important on account of the abundance and good quality of the ore, though the immediately adjoining coal beds, B and C, are scarcely of sufficient thickness to be available towards the manufacture of iron at this place, the thicker workable seam E, with its companion the limestone lies higher up in the same hill. A heavy bed of conglomerate, the uppermost of F. XII. underlies the coal B, and iron ore at a very moderate distance, suggesting that the coal A, if indeed it continue in this neighborhood, must lie beneath this rock, as we find it further south. Such alternation of the lower coal seams with the upper beds of F. XII. is of frequent occurrence in all our coal fields, both bituminous and anthracitic.

Eastward from the old furnace of Jacob's creek occur the two coal beds, B and C, with their interposed iron ore. Here they are only twenty feet apart and show a corresponding reduction of thickness, the bed B measuring but one foot, and the bed C one foot and a half. In the interval we find six inches of good iron ore embraced within four feet of shale.

Near the above spot the red shale F. XI. shows its limestone cropping out in a stratum 15 feet in thickness. The iron ore near the top of the formation was formerly procured for the furnace. It lies in several bands whose aggregate thickness is about 8 inches.

The topographical features of the section of the basin we have been describing are somewhat peculiar, owing to the prevalence of soft shales in that portion of the series occupied by the hills of the central belt of the valley. The summits are often quite plane, though gently sloping in conformity with the gentle dip of the strata.

Of the hills in the middle of the basin near the county line dividing Westmoreland and Fayette.

Let us shift our attention now to that part of the valley which borders the dividing line of Westmoreland and Fayette. In the rolling surface of this district we detect many of those indentations in the hills called coal benches, very few of which however have been penetrated for the coal. These hills contain only the middle portion of the coal series or the strata which intervene between the bed B, and the large upper seam I. Hence the relatively small amount of workable coal in this neighborhood. At the base of the hills the coal E and its limestone certainly exist, and perhaps the next inferior bed D, which on the Conemaugh is in some places 6 feet thick, but probably thinner here. These are the only available strata in all the central region between the head waters of Indian creek and the southern branches of the Loyalhanna.

Of the strata on Indian creek.

Passing southward, down the tributaries of Indian creek, we follow it for eight or ten miles through the coal measures, descending in the stratification until we reach Fayette furnace at the mouth of Laurel run, where the stream flows over rocks that may be referred either to the upper part of F. XII. or the lower portion of the coal measures; for coal A, (here one hundred feet beneath the creek,) may be referred as well to the former as to the latter. Continuing down the creek, which enters lower and lower strata in its course, the underlying coal bed A, at length appears about two miles below St. John's furnace, where it is embraced among massive sandstones, that form a series of steps at their outcrop along the channel of the creek, nearly the whole way from a mile above the furnace to the mouth of the stream. We may consider the main body of F. XII. to commence below the coal bed, and to embrace all the rocks thence to near the mouth of the creek where the stream at last reaches the red shales of F. XI. exposing them, in a thickness of fifty feet, resting upon their well marked calcareous sandstone at the water level. As the rocks here dip gently eastward, towards the middle of the basin, we find these beds of F. XI. disappearing below the Youghiogheny as we ascend it in the same direction, the neighboring bluffs showing all the way at their base vast bodies of debris in the form of broken blocks of sandstone and conglomerate, derived from the cliffs above, where F. XII. rises nearly perpendicularly two hundred feet from the stream. Regarding F. XII. as terminating at the first coal seam, A, the total thickness of the formation will be about one hundred and fifty feet; but if we make it to embrace the coal and the over resting conglomerate and sandstone, the whole will measure about two hundred and fifty feet. Ascending the river, F. XI. is out of reach until we get about two miles above the Ohiopile falls; here it emerges with a tolerably steep western dip and is followed, as we approach the gap of the mountain, by the rocks of F. X., and finally, at the axis of the ridge, by those of formation IX.

The sections designed to exhibit the stratification in this region were unavoidably meagre, though data enough were collected to establish an accordance among themselves and between them and the corresponding parts of a more complete section obtained in the neighborhood of Fayette furnace.

In this principal section, (which is represented in the engraved sheet,) the largest coal seam of this part of the valley is the bed B, which near the furnace yields 3½ feet of good coal, and an extra foot of an inferior kind. It has been also exposed at intervals for several hundred feet by the erosive action of the stream along Indian creek just above the mouth of Laurel run; it was once worked at this place by stripping it at its outcrop. At both the above localities it underlies a bed of brown shale. The coal may be seen cropping out in a deep ravine to the west of Indian creek, crossed by the turnpike leading to Connellsville. It was once mined by stripping at St. John's furnace, where its elevation above the stream is about eighty feet.

The limestone accompanying this coal appears where the turnpike crosses Indian creek, in a bed 8 feet thick. About fifteen feet above the coal lies a band of iron ore 8 inches thick.

The coal seam, A, previously stated to be one hundred feet lower in the series was passed in boring a salt well near the furnace. Its thickness in the well has been stated to us at 1 foot, agreeing with its dimensions at its outcrop in the creek's bed, two miles below St. John's furnace. This coal is of excellent quality.

Fifty feet above the coal bed B, lies C, once opened where the turnpike ascends the first hill west of Indian creek, and stated to be 3 feet thick, but of indifferent quality.

About one hundred feet above this, a band of light colored pure limestone has been quarried, the thickness of which could not be ascertained from the falling in of the earth. A bed of coal overlies it within a few feet, yielding it is stated, 3 feet of good coal. Strata deemed to be the same, were met with four miles further south, on Mr. M'Koun's farm, where the coal is in two bands separated by nearly four feet of fire clay, the upper band showing 3 feet of coal, containing no impurity but sulphuret of iron, and the lower band, 1½ foot of equally good quality. A calcareous spring, indicating the outcrop of the limestone, issues about fifteen feet below the outcrop of the coal. About forty feet above the coal bed occurs a bench which suggests the presence of another. Unable to procure any extensive continuous section of the strata in this vicinity, we are in some doubt to what part of the coal measures to refer the first mentioned seam with its limestone, for we may regard it as either B, or E, of the series. Appearances incline us to refer it to the former.

At Lennard's, one mile north of Bear run, appears a band of limestone belonging to the coal bed E, though the coal itself has not yet been seen here. Fifty feet higher in the hill is an outcrop crossing the road which appears to belong to a large bed. Westward of Lennard's, towards the river, two lower coal seams have been opened on a small run; the uppermost, coal B, being 1½ foot thick, and the undermost, one hundred feet further down, being 2 feet thick. No limestone has yet been recognized accompanying the first of these coals.

To return to the section at Fayette furnace, we find from fifty to sixty feet above the coal E, and its limestone, a well marked bench containing probably the highest seam which has resisted the denuding action of the waters in this part of the valley.

On Bear run, three miles north of the Ohiopile falls, and one mile from the river by the course of the run, a coal bed has been opened yielding 3 feet of very pure coal. It overlies a mass of sandstone, this rock constituting the principal material between this level and that of the river below. It was impossible to decide upon the precise position in the series held by this bed, though every thing except the absence of a band of limestone suggests its reference to the seam B. It is regarded as the purest coal in this section of the valley. A very irregular coal seam occurs thirty feet down between the sandstone; it varies from an inch to a foot in thickness, and it probably corresponds with a very irregular bed observed at the Ohiopile falls, and again on Maiden creek; at which latter place it rests beneath twenty feet of sandstone and is 2 feet thick, having the same appearance as if it had been crushed. May not this coal be the irregular commencement of a bed holding an intermediate position between A and B, and which, in other districts, may assume the character of an important and continuous stratum?

Ascending the Youghiogheny from its falls, we come in the distance of about a mile upon the limestone and calcareous sandstone of the lower part of F. XI. The limestone, which varies in quality from a very arenaceous rock to one well adapted to making lime, is at least 30 feet in thickness. Sherman's run exposes the sandstone strata of F. X. throughout nearly its whole course. Formation XII. forms high hills to the west of Sherman's run, its outcrop presenting huge blocks of conglomerate and sandstone. Under this outcrop near the junction of the red shale, F. XI., are to be seen loose pieces of the iron ore so common in this situation. Formation XI. here contains, however, much more sandstone than it shows in the country further to the N. E. In this vicinity, which is at the western base of the broad mountain ridge of Laurel hill, the rocks manifest that steepness of dip so common on the western side of all our great anticlinal axes, the inclination here being as much as 45°.

Signs of coal occur near the head of Bear run, where the hills rise to an elevation of nearly two hundred and fifty feet above the position occupied by F. XII. Near their summits we find a coal smut, indicating a large bed, probably the same with that already noticed as appearing in the road at Lennard's. In F. XII. occurs here a bed of coal 2 feet thick, being either the seam A, or the variable interpolated one before described.

Of the part of the basin south of the Youghiogheny.

That part of the valley embraced between the Youghiogheny and the southern line of the state has yielded us less satisfactory data for a description of its geology than any section further north. The season adapted to field duties being far advanced and the country requiring a leisurely examination to reveal its obscure stratification, little was accomplished beyond what amounts to a reconnaissance to its topography and the identification of a few of its beds.

A seam of coal was formerly opened and mined to a small extent on the first stream which enters the river from the west below Cucumber run. It is 4 feet and a few inches thick, including 5 inches of slate near the top. Lying on the banks of a stream having little fall and in a neighborhood deficient in exposures of the strata, it was impossible to settle its position in the series, though the evidence preponderates which would refer it to one of the lower beds. Did any evidences of limestone accompany it we should regard it as a part of bed B; yet this rock being elsewhere sometimes several feet below its coal it may exist here under the level of the run. Though no other coal bed has been discovered in this neighborhood S. W. of the falls, the great height of the hills and the occurrence of several benches imply the existence of at least four or five seams in all.

Near the middle of the valley and half a mile north of the National road coal occurs in the lowest grounds. Fragments of conglomerate abounding near it induce us to refer it to the bed B, the nearest to F. XII. The seam is 3 feet thick, parted in the middle by an inch of slate; it yields a fuel well adapted to the purposes of the blacksmith. It is worked by stripping only. The strata here are level. About thirty feet above this, in an adjoining hill, is seen the smut of another coal seam, (C?) which corresponds very well in position with the bed at Smythfield in the basin east of the mountain. Another bench, showing black coal slate, (coal D?) appears 25 feet above this. These three are all the coal beds thought to exist in this neighborhood. A fourth of a mile south of the National road and a mile east of the former place a coal bed, (C?) corresponding in character with the Smythfield seam, is worked at its outcrop. The bed contains, first, a layer of coal 2 feet thick, resting on 1 foot of good fire clay, this underlaid by 15 inches of coal which also reposes on good fire clay. The coal, otherwise pure, is somewhat sulphurous. Twenty-five feet above this may be noticed another coal bench, (coal D?)

At Chalk hill on the National road, not far from Stewart's furnace, occurs an indifferent slaty bed of coal, overlaid by a heavy bed of olive shale. It is 1 foot 6 inches thick. A well sunk 50 feet below this coal reached no other bed, nor did it meet the coarse sandstone, F. XII., which crops out within less than a mile west of Chalk hill, towards Chesnut ridge, here erroneously called Laurel hill. Higher up the mountain the calcareous sandstone near the base of F. XI. displays itself, being used as a road stone, for which it is well suited by its toughness.

The lowest seam of coal along the western margin of the basin might, I conceive, be easily detected by following the indications of the rocks exposed along the National turnpike. Its discovery here would prove of some utility.

Of the Coal Measures interposed between F. XI. and F. XII.

In describing the strata in the neighborhood of Turkey foot, in the basin east of Laurel hill, we made mention of a thin group of coal bearing rocks having no connexion with the main body of the coal measures, but holding a position corresponding to the upper layers of F. XI. and the lower rocks of F. XII. These earlier formed carboniferous strata gradually developing themselves in our progress to the S. W., do not show themselves conspicuously in the basin west of Laurel hill until we reach this district south of the Youghiogheny, corresponding to the Turkey foot country on the opposite side of the mountain. Near Stuart's furnace before referred to, these interpolated coal strata contain a seam of excellent coal 4 feet in thickness. It lies entirely below the coarse rocks of F. XII. and twenty feet below the band of iron ore which *usually* marks the common limit of this formation and the red shale, F. XI. The ore here occupies a brown shale, so that it may be considered as appertaining to the coal measures which thus form as it were a subordinate part of the underlying red shale formation. This ore occurs in four separate bands, two of which within three feet of each other are near enough to be worked together. The upper band is less than an inch in thickness, while the lower varies from 1½ to 3 inches. These were the most productive layers known here, until others a little thicker were recently discovered in the same formation north of the National road, and four miles from the furnace. In the new locality the ore is in two adjacent layers, equivalent in all to a thickness of about 8 inches; its quality is very good. The same ore, at the top of the red shale, was formerly worked on the Clay turnpike on Chestnut ridge near Connellsville and is said to have proved abundant and good.

CHAPTER III.

Chemical composition of various Iron Ores, Coals, Limestones and other substances.

Having undertaken an extensive and systematic chemical examination of our *iron ores*, *coals*, *cements*, *limestones*, and other useful minerals, with a view to settle precisely the composition and properties of each, I propose to pursue here the plan adopted in my last annual report, and submit the results of a number of the analyses made during the past year by my assistants, Dr. R. E. Rogers, Martin H. Boye, and Professor James B. Rogers.

The limited scope of an annual report, and the yet unfinished state of some of our chemical researches which need much care and time in the experiments, induce me to postpone to the pages of my final report various conclusions and discussions of a practical character, suggested by the analytical details now presented. In the mean while, however, it will interest all who are directly or indirectly concerned in developing or using any of the mineral treasures of the State, to find in the following pages the true composition of a number of our ores, coals and limestones, including in the latter several varieties employed as fluxes and hydraulic cements.

I shall classify the analyses according to the geological order of the formations in which the different minerals occur, adopting as in all my descriptions the ascending order.

Section I.

Analyses of Ores.

I. *Analyses of Iron Ores from the primary formation.*

Magnetic Iron Ore from Trine and Fegely's mine, three miles S. E. from Metztown, Berks county. This ore occurs as a vein in gneiss.

Description.—Color dull iron black, imperfectly crystallized in dodecahedrons; lustre splendent; possesses magnetic polarity.

Composition in 100 *parts:*

Magnetic oxide of iron,	88.92
Alumina,	a trace
Silica,	10.60
Water,	0.20
Loss,	0.28
	100.00

This specimen contains 65.52 per cent. metallic iron.

Magnetic Oxide of Iron from one mile S. E. of Hellerstown, Lehigh county.

Description.—Color iron black; structure somewhat laminated, presenting imperfect rhombic crystalline faces; lustre semi-metallic; possesses magnetic polarity.

Composition in 100 *parts:*

Magnetic oxide of iron,	85.50
Alumina	trace
Silica,	12.60
Water,	1.25
Loss,	0.65
	100.00

This specimen contains 63.00 per cent. metallic iron.

II. *Analysis of Iron Ores of Formation, II. & III.*

IRON ORE from Hartman's field, Northampton county.

Description.—Structure porous, cellular; texture soft and crumbly; color, bright chesnut brown.

Composition in 100 *parts:*

Per oxide of iron, - - - - -	65.60
Alumina, - - - - - - -	1.00
Silica and insoluble matter, - - - -	17.82
Water, - - - - - - - -	14.98
Loss, - - - - - - - -	0.60
	100.00

The metallic iron amounts to 45.92 per cent.

IRON ORE from Albright's new mine, near the church south of Trexlerstown, Lehigh county.

Description.—Red hematite; structure distinctly fibrous, concretionary and stalactitic; color brownish red, with bluish grey points on the surface; lustre considerable.

Composition in 100 *parts:*

Per oxide of iron, - - - - -	82.00
Alumina, - - - - - - -	a trace
Silica and insoluble matter, - - - -	5.32
Water, - - - - - - - -	12.25
Loss, - - - - - - - -	0.43
	100.00

This specimen contains 57.40 per cent. metallic iron.

IRON ORE from Jacob Rice's, five miles N. W. of Bethlehem, Lehigh county. Shell ore thirty feet from surface.

Description.—Structure, porous cellular, quite brittle; color, rich chesnut brown.

Composition in 100 parts:

Per oxide of iron,	70.25
Alumina,	1.55
Oxide of manganese,	a trace
Silica and insoluble matter,	16.40
Water,	11.40
Loss,	0.40
	100.00

This specimen contains 49.17 per cent. metallic iron.

Iron Ore from Jacob Rice's, same locality as above, found from forty to fifty feet from surface. It is a pipe ore.

Description.—Structure pipes, closely adhering, compact brittle; color chesnut brown; surface stained red from adhering red oxide.

Composition in 100 parts:

Per oxide of iron,	79.12
Alumina,	1.56
Silica and insoluble matter,	4.80
Water	13.98
Loss,	0.54
	100.00

This specimen contains 55.38 metallic iron.

Iron Ore from Brotzman's, Northampton county.

Description.—Amorphous, and somewhat mammillary; color brown, in some places mottled with white specks of clayey or siliceous matter, in others dark brown and shining. Average of the mass taken for analysis.

Composition in 100 parts:

Per oxide of iron,	71.72
Per oxide of manganese,	0.70
Silica and insoluble matter,	16.55
Water,	11.03
	000.00

This specimen contains 49.78 per cent. metallic iron.

IRON ORE from Dillinger's farm, one mile S. E. of Hellerstown.

Description.—Brown hematite; compact, interspersed with veins of shining fibrous hematite; color, brown.

Composition in 100 *parts:*

Per oxide of iron,	85.71
Oxide of manganese,	1.05
Alumina,	a trace
Silica and insoluble matter,	1.50
Water,	11.74
	100.00

This specimen contains 59.42 per cent. metallic iron.

IRON ORE from Richards's, Lehigh county.

Description.—Structure somewhat nodular, amorphous; color brown throughout the map, coated externally with a yellow clay, in some parts blue. Average of the whole selected for analysis.

Composition in 100 *parts:*

Per oxide of iron,	71.72
Oxide of Manganese,	10.42
Alumina,	a trace
Silica and insoluble matter,	4.12
Water,	13.21
Loss,	0.53
	100.00

This specimen contains 49.72 per cent. metallic iron.

IRON ORE from Moyer's, four miles N. N. W. from Allentown, Lehigh county, called lump ore.

Description.—Structure compact massive; color dark chesnut brown.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	72.17
Alumina, - - - - - - - -	1.50
Oxide of manganese, - - - - - -	trace
Silica and insoluble matter, - - -	12.30
Water, - - - - - - - - -	14.00
Loss, - - - - - - - -	0.03
	100.00

This specimen contains 50.51 per cent. metallic iron.

IRON ORE from same locality as above. Pipe ore.

Description.—Structure irregularly stalactitic; pipes close adhering; color rich chesnut brown.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	79.21
Alumina, - - - - - - - -	0.75
Manganese, - - - - - - -	none
Silica and insoluble matter, - - -	7.50
Water, - - - - - - - - -	11.00
Loss, - - - - - - - - - -	0.54
	100.00

This specimen contains 55.44 per cent. metallic iron.

IRON ORE from Henry Goetz's, five miles N. N. W. from Bethlehem, Lehigh county, called hard ore.

Description.—Massive, compact; fracture conchoidal; color dull black brown; surface lustrous, iridescent and resinous.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	84.00
Alumina, - - - - - - - -	a trace
Silica and insoluble matter, - - - - -	4.10
Water, - - - - - - - - -	11.60
Loss, - - - - - - - - - -	0.30
	100.00

This specimen contains 58.80 metallic iron.

Iron Ore from J. Isaac Breinig's farm, one mile N. W. from Breinigsville, Lehigh county.

Description.—Structure massive, quite compact, and close grained; color blackish brown; surface coated with a velvet-like oxide.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	75.54
Alumina, - - - - - - -	a trace
Silica and insoluble matter, - - -	11.90
Water, - - - - - - - - -	12.15
Loss - - - - - - - - -	0.41
	100.00

This specimen contains 52.87 per cent. metallic iron.

Iron Ore from Xanders's Lehigh county.

Description.—Cellular, porous, brittle; color chesnut brown, interspersed with bright reddish yellow spots.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	77.23
Alumina, - - - - - - - -	2.75
Lime, - - - - - - - - -	a trace
Manganese, - - - - - - - -	a trace
Silica and insoluble matter, - - -	5.80
Water, - - - - - - - - -	13.92
Loss, - - - - - - - - -	0.30
	100.00

This specimen contains 54.06 per cent. metallic iron.

Iron Ore from bank of Hall and Rowle, three-fourths of a mile S. E. of Greenwood, Kishacoquillas valley, Mifflin county.

Description.—Hard, granular, porous; grains round, internally compact; color brown, with lighter colored interstitial deposit.

Composition in 100 *parts:*

Per oxide of iron,	82.88
Alumina,	0.53
Silica and insoluble matter	4.21
Water,	12.38
	100.00

This specimen contains 57.47 per cent. metallic iron.

Iron Ore from Pennington bank, two and a half miles S. W. of Warrior-marktown, Huntingdon county.

Description.—Structure in some parts compact, in others cellular, cells lined with red oxide; color chesnut brown.

Composition in 100 *parts:*

Per oxide of iron,	76.50
Alumina,	none
Oxide of manganese,	2.70
Silica and insoluble matter,	7.50
Water,	12.50
Loss,	0.80
	100.00

This specimen contains 52.50 per cent. iron.

Iron Ore from three-fourths of a mile N. E. of Pennsylvania furnace, old Pennington bank, Huntingdon county.

Description.—Texture compact, close grained; structure somewhat columnar; color rich brown.

Composition in 100 *parts:*

Per oxide of iron,	84.80
Alumina,	1.50
Insoluble matter,	3.00
Water,	10.00
Loss,	0.70
	100.00

Per cent. metallic iron 59.36.

IRON ORE from Pond bank, Pennsylvania furnace, new digging, Huntingdon County.

Description.—Structure slender pipes, closely adhering, brittle; color rich brown.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	76.50
Alumina, - - - - - - - -	2.55
Insoluble matter, - - - - - -	11.40
Water, - - - - - - - -	9.10
Loss, - - - - - - - -	0.45
	100.00

Per cent. metallic iron 53.55.

IRON ORE from Green Village bank, Caledonia Furnace, Franklin county.

Description.—Structure pipes, quite compacted; color chesnut brown.

Composition in 100 *parts:*

Per oxide iron, - - - - - -	76.00
Alumina, - - - - - - - -	2.25
Insoluble matter, - - - - - -	11.00
Water, - - - - - - - -	10.25
Loss, - - - - - - - -	0.50
	100.00

This specimen contains 52.20 per cent. metallic iron.

IRON ORE from Formation III. Hanover furnace ore bank, Lowrey's knob, Bedford county.

Description.—Brittle, granular, in some parts of a brick red color, in others opalescent, argillaceous.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	36.71
Alumina, - - - - - - - -	14.46
Insoluble matter, - - - - - -	32.36
Manganese, - - - - - - -	a trace.
Water, - - - - - - - - -	16 47
	100.00

Per cent metallic iron 25.45.

II. *Analyses of Iron Ores from Formation V.*

Iron Ore from synclinal axis of Little Cove, Franklin county.

Description.—Color dark red and brown; granular, including in some portions pieces of imbedded quartz, and in others numerous grains of sand, presenting the appearance of a coarse sandstone, with ferruginous cement, the latter preponderating.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	30.38
Alumina, - - - - - - - -	1.20
Silica and insoluble matter, - - - - -	67.00
Water, - - - - - - - -	1.42
	100.00

This specimen contains 21.06 per cent. metallic iron.

Iron Ore from Mifflin, Juniata county.

Description.—Structure coarse slaty granular; somewhat micaceous, and fossiliferous; color chesnut brown.

Composition in 100 *parts:*

Per oxide of iron, - - - - - -	70.00
Alumina, - - - - - - - -	a trace.
Silica and insoluble matter, - - - -	24.24
Oxide manganese, - - - - -	a trace.
Water, - - - - - - - - -	5.40
Loss, - - - - - - - -	0.40
	100.00

IRON ORES from Danville, Columbia county, fossiliferous; two varieties, one siliceous and the other calcareous.

Description: Calcareous variety.—Structure somewhat slaty; micaceous, fossiliferous; lustre glimmering; color dark bluish brown.

Composition in 100 parts:

Per oxide of iron, - - - - - -	30.34
Oxide manganese, - - - - - -	a trace.
Carbonate of lime, - - - - - -	62.43
Carbonate of magnesia, - - - - -	2.79
Silica and insoluble matter, - - - -	2.64
Water, - - - - - - - -	1.80
	100.00

Per cent. of metallic iron 21.03.

Description: Siliceous variety.—Structure massive, occuring in plates of variable thickness, resembling slabby red sandstone; color brick red, somewhat fossiliferous, not micaceous, and free from lustre.

Composition in 100 parts:

Per oxide of iron, - - - - - -	70.63
Alumina, - - - - - - -	0.57
Carbonate of lime, - - - - - -	2.46
Silica and insoluble matter, - - -	23.77
Water, - - - - - - - -	2.57
	100.00

Per cent metallic iron 48.97.

IRON ORE from Smith's Gap, Blue mountain, Dauphin county.

Description.—Massive, rounded at the edges, coarse grained, apparently composed of small masses of coarser ore imbedded in a paste of brown hematite; color mottled, dark brown.

Composition in 100 parts:

Per oxide of iron,	68.00
Alumina,	6.60
Silica and insoluble matter,	13.30
Water,	11.70
Loss,	0.40
	100.00

This specimen contains 47.06 per cent. metallic iron.

Iron Ore from two miles south of Landisburg, top of ridge, anticlinal axis, Perry county.

Description.—Structure somewhat slaty, brittle, micaceous, highly fossiliferous; color dull brown, with glimmering lustre.

Composition in 100 parts:

Per oxide of iron,	76.45
Oxide of manganese,	1.50
Alumina,	1.25
Silica and insoluble matter,	14.40
Water,	5.70
Loss,	0.70
	100.00

This specimen contains 53.51 per cent. metallic iron.

Iron Ore from Turtle creek, west branch of the Susquehanna, Union county.

Description.—Compact, coarse, siliceous; color pink; resembles the hard ore of Danville.

Compostion in 100 parts:

Per oxide of iron,	37.64
Alumina,	trace
Insoluble matter,	59.00
Water,	3.20
Loss,	0.16
	100.00

Per cent. metallic iron 26.32.

III. *Analyses of Iron Ores of Formation VI.*

Iron Ore from Tuckahoe, Huntingdon county.

Description.—Structure cellular, cells large and angular, and lined with a bluish coating; close grained, hard and brittle; color dull brick red.

Composition in 100 parts:

Per oxide of iron,	71.50
Alumina,	2.50
Oxide of Manganese,	a trace
Silica and insoluble matter,	20.40
Water,	5.00
Loss,	0.60
	100.00

This specimen contains 50.00 per cent. metallic iron.

Iron Ore from same locality as above, Allegheny furnace ore bank.

Description.—Cellular, walls of cells compact and lined with a pulverulent oxide; color light brownish yellow.

Composition in 100 parts:

Per oxide of iron,	69.80
Oxide of manganese,	a trace
Alumina,	2.30
Silica and insoluble matter,	18.40
Water,	8.70
Loss,	0.80
	100.00

This specimen contains 48.86 per cent. metallic iron.

IV. *Analyses of Iron Ores of Formation VIII.*

Iron Ore, Bog ore, from base of Warrior's ridge, Woodcock valley, lower part of the formation.

Description.—Structure massive, texture brittle and earthly; color dull ochreous brown; vegetable fibres, interspersed through the map.

Composition in 100 *parts:*

Per oxide of iron,	75.22
Alumina,	2.50
Silica and insoluble matter,	7.75
Oxide of manganese,	trace
Organic matter,	2.80
Water,	11.45
Loss,	0.28
	100.00

This ore contains 52.65 per cent. metallic iron.

Iron Ore from six miles west of Pinegrove.

Description.—Structure somewhat slaty, porous, cellular, fossiliferous; color mottled brown and drab.

Composition in 100 *parts:*

Per oxide of iron,	37.00
Alumina,	4.20
Carbonate of lime,	1.50
Silica and insoluble matter,	45.90
Water,	11.25
Loss,	0.15
	100.00

This specimen contains only 25.90 per cent. metallic iron.

Iron Ore from Chester ridge, three-fourths of a mile west of Chester furnace, Huntingdon county.

Description.—Compact, easily broken; color variegated brown black; easily scratched by the nail.

Composition in 100 *parts:*

Per oxide of iron,	66.92
Per oxide of manganese,	14.64
Alumina,	1.93
Insoluble matter,	7.57
Water,	9.48
	100.00

Per cent. metallic iron, 46.40. This ore is from the upper part of Formation VII.

Iron Ore from upper part Formation VIII. near its contact with IX., Lycoming creek.

Description.—Granular, with a structure tending to laminated, shining, fossiliferous; color chocolate brown, powder red.

Composition in 100 *parts:*

Per oxide of iron,	48.80
Alumina, Oxide of manganese, Lime,	a trace.
Silica and insoluble matter,	49.38
Water,	1.68
Loss,	0.14
	100.00

This specimen contains 33.83 per cent metallic iron.

Iron Ore from two miles west of Pinegrove.

Description.—Structure slaty, porous, cellular, fossiliferous; color dull earthy brown.

Composition in 100 *parts:*

Per oxide of iron,	32.00
Alumina,	0.50
Lime,	1.00
Silica and insoluble matter,	60.00
Water,	6.00
Loss,	0.50
	100.00

This specimen contains only 22.40 per cent metallic iron.

V. *Analyses of Iron Ores of Formation XI.*

Iron Ore from Bennett's branch of Sinnemahoning, one and a half miles above Warner's, Clearfield county.

Description.—Structure compact close grained; fracture conchoidal; color dull grey; surface ochreous.

Composition in 100 *parts:*

Carbonate of iron,	82.20
Per oxide of iron,	6.50
Alumina,	1.00
Silica and insoluble matter,	6.65
Water,	3.40
Loss,	0 25
	100.00

This specimen contains of metallic iron 44.22 per cent.

IRON ORE from same locality as above:

Description.—Structure, less compact and coarser than the above; fracture semi-crystalline, somewhat nodular; color grey.

Composition in 100 *parts:*

Carbonate of iron,	63.80
Alumina,	0.75
Oxide of manganese,	1.00
Silica,	30.90
Water,	2,75
Loss,	0.80
	100.00

This specimen, contains 30.28 per cent. metallic iron.

BOG IRON ORE from hard ores of XI., three or four miles W. of top of Allegheny mountain, near head of East fork of west branch of Muddy river, Cambria and Clearfield line.

Description.—Structure amorphous, cellular, brittle, somewhat earthy; color rich brown; contains veins of brown hematite.

Composition in 100 *parts:*

Per oxide of iron,	75.15
Alumina,	0.90
Oxide of manganese,	4.00
Organic matter,	0.40
Silica and insoluble matter,	3.40
Water,	16.20
	100.00

This specimen contains 52.60 per cent. metallic iron.

IRON ORE from head of Garey's run, Fayette county.

Description.—Structure nodular and concentric, internally close grained, and of a light dove color, externally somewhat hematitic; color chesnut brown, exhibiting on the surface innumerable iridescent spots.

Composition in 100 parts:

Carbonate of iron,	84.14
Per oxide of iron,	2.78
Carbonate of lime,	3.00
Alumina,	0.75
Manganese,	a trace
Water,	5.00
Silica and insoluble matter,	6.50
	000.00

This specimen contains 40.62 per cent. of metallic iron.

IRON ORE from Garey's run, Fayette county.

Description.—Structure kidney shaped, texture of the interior unweathered, portion close grained and compact; color greyish blue; fracture smooth, slightly conchoidal.

Composition in 100 parts:

Carbonate of iron,	75.50
Carbonate of lime,	2.50
Carbonate of magnesia,	1.35
Alumina,	2.80
Silica and insoluble matter,	15.55
Water,	2.00
Loss,	0.30
	100.00

This specimen contains 38.22 per cent. of metallic iron.

IRON ORE, Lavages' diggings, Trough creek, Huntingdon county.

Description.—Ore compact, jaspery; color redish brown; fracture conchoidal.

Composition in 100 *parts:*

Per oxide of iron,	88.9
Alumina,	none
Silica and insoluble matter,	a mere trace
Water,	11.0
Loss,	0.1
	100.00

This specimen contains 69.93 per cent. metallic iron.

Iron Ore from S. E. of Blairsville, Indiana co., on the Conemaugh.

Description.—Nodular, somewhat spathose, apparently composed of a congeries of irregular materials, presenting a mottled green and red appearance.

Composition in 100 *parts:*

Carbonate of iron,	37.80
Carbonate of lime,	5.50
Carbonate of magnesia,	7.50
Alumina,	7.60
Silica and insoluble matter,	37.80
Water,	3.50
Loss,	0,30
	100,00

Metallic iron 18.27 per cent.

Iron Ore from Christopher Hill's, west side of Chesnut ridge, Indiana county.

Description.—In lenticular shaped masses, compact; color of map cinnamon brown; surface coated with argillaceous crust.

Composition in 100 *parts:*

Per oxide of iron,	51.25
Alumina,	5.96
Carbonate of lime,	2.00
Ox. of Manganese,	a trace,
Silica and insoluble matter,	36.50
Water,	4.00
Loss,	0.19
	100.00

This specimen contains 35.87 per cent. metallic iron.

IRON ORE from the head waters of Brodhead's creek, Monroe county.

Description.—Structure slaty, coarse grained, and siliceous; color grey, surface covered with a brown ferruginous crust.

Composition in 100 *parts:*

Carbonate of iron,	12.43
Per oxide of iron,	3.43
Alumina,	1.50
Carbonate of lime,	4.00
Oxide of Manganese,	2.20
Silica and insoluble matter,	72.20
Water,	4.00
Loss,	0.24
	100.00

This specimen contains 8.26 per cent. of metallic iron.

IRON ORE from the west side of Chesnut ridge, on the Pennsylvania canal, Westmoreland county.

Description.—Structure compact, close grained; fracture somewhat conchoidal and jaspery; color purple brown, with a tinge of green.

Composition in 100 *parts:*

Per oxide iron,	61.50
Alumina,	1.25
Lime and magnesia,	traces
Silica and insoluble matter,	31.44
Water,	5.20
Loss,	0.61
	100.00

This specimen contains 43.05 per cent. metallic iron.

IRON ORE from Hare's valley, Huntingdon county.

Description.—Massive, micaceous, soft, unctuous, flat, and somewhat laminated; color purplish red.

Composition in 100 *parts:*

Per oxide of iron,	97.54
Alumina,	0.18
Insoluble matter,	3.12
	100.00

Per cent. metallic iron 67.63.

VI. *Analyses of Iron Ores of Formation XIII.*

Iron Ore, argillaceous carbonate, from the St. Clair tract, Pottsville, Schuylkill county.

Description.—Structure nodular, concentric, rather compact; color internally slate blue, externally dirty brown. Average of the whole taken for analysis.

Composition in 100 *parts:*

Carbonate of iron,	42.38
Carbonate of Manganese,	3.64
Per oxide of iron,	21.32
Alumina,	a trace
Silica and insoluble matter,	27.63
Water,	5.03
	100.00

Per cent. metallic iron 34.86.

Iron Ore from the same locality as above.

Description.—Structure somewhat nodular, compact; color slate blue.

Composition in 100 *parts:*

Carbonate of iron,	66.67
Per oxide of iron,	2.55
Carbonate of manganese and magnesia,	traces
Carbonate of lime,	8.25
Alumina,	2.25
Silica and insoluble matter,	13.90
Water,	6.10
Loss,	0.28
	100.00

This specimen contains 33.96. per cent. metallic iron.

IRON ORE, Mount Laffy mine, Pottsville.

Description.—Structure nodular, massive, compact; color slate brown; feel meagre; in parts unctuous.

Composition in 100 *parts:*

Carbonate of iron,	39.54
Per oxide of iron,	14.57
Carbonate of manganese,	0.50
Lime and magnesia,	traces
Alumina,	0.50
Silica and insoluble matter,	40.00
Water,	4.60
Loss,	0.29
	100.00

This specimen contains 32.52 per cent. metallic iron.

IRON ORE from same locality as above, Pottsville.

Description.—Structure nodular, compact; slate blue; minute crystals of yellow iron pyrites are disseminated through the mass.

Composition in 100 *parts:*

Carbonate of iron,	45.50
Carbonate of manganese,	1.00
Carbonate of magnesia,	7.50
Carbonate of lime,	6.00
Silica and insoluble matter,	30.00
Bi sulphuret of iron,	0.60
Water,	7.00
Alumina,	2.25
Loss,	0.15
	100.00

This specimen contains 22.05 per cent. metallic iron.

IRON ORE from another bed at the same locality, Mt. Laffy, Pottsville.

Description.—Structure flattened, nodular; texture moderately close grained; color brown, slaty; feel, slightly unctuous.

Composition in 100 *parts :*

Carbonate of iron,	39.54
Per oxide of iron,	14.57
Lime and magnesia,	traces
Carbonate manganese,	0.50
Alumina,	0.50
Water,	4.50
Loss,	0.39
Silica and insoluble matter,	40.00
	100,00

This specimen contains 32.52 per cent. metallic iron.

IRON ORE from Zachariah's run, Pottsville.

Description.—Structure laminated, slaty, micaceous, crystalline, quartz running at right angles to the laminae; color slate blue; surface coated with a thin crust of brown oxide, and presenting a glazed appearance.

Composition in 100 *parts :*

Carbonate of iron,	31.07
Per oxide of iron,	14.37
Carbonate of manganese,	1.25
Carbonate of magnesia,	2.20
Alumina,	1.00
Silica and insoluble matter,	44.80
Water,	5.00
Loss,	0.31
	100.00

This specimen contains 25.05 pet cent. metallic iron.

IRON ORE from the same locality, Zachariah's run.

Description.—Structure nodular, somewhat slaty, compact; color dark blue, but non-decomposed on the outside than the preceding, the ferruginous crust being more considerable.

Composition in 100 *parts:*

Carbonate of iron,	35.13
Per oxide of iron,	28.10
Carbonate of manganese,	2.39
Carbonate of lime,	0.92
Carbonate of magnesia,	8.79
Alumina,	0.91
Silica and insoluble matter,	21.62
	100.00

This specimen contains 41.88 per cent. metallic iron.

IRON ORE from Guinea hill. Pottsville.

Description.—Nodular, concentric, internally hard, externally friable; color of surface dirty brown, of interior slate blue; earthy and meagre to the touch. Average of the whole taken for analysis.

Composition in 100 *parts*:

Carbonate of iron,	31.53
Per oxide of iron,	31.31
Alumina,	a trace
Manganese,	a trace
Silica and insoluble matter,	31.08
Water,	6.06
Loss,	.02
	100.00

This specimen contains 37.14 per cent. metallic iron.

IRON ORE from York farm, Rabbit hole vein, near Pottsville.

Description.—Compact; color dull bluish black, like a dark colored limestone.

Composition in 100 *parts:*

Carbonate of iron,	48.33
Per oxide of iron,	15.06
Carbonate of manganese,	2.03
Carbonate of magnesia,	5.11
Carbonate of lime,	3.11
Alumina,	1.28
Carbonaceous matter,	1.81
Silica and insoluble matter,	20.25
Water,	3.02
	100.00

This specimen contains 33.35 per cent. metallic iron.

IRON ORE from Port Carbon, Schuylkill county.

Description.—Structure thin, laminated, rather friable; clay interposed between the laminae; small grains of per oxide of iron interspersed through the mass; color dull brown.

Composition in 100 *parts:*

Per oxide of iron,	53.56
Oxide of manganese,	1.08
Alumina,	trace
Silica and insoluble matter,	36.01
Water,	9.35
	100.00

Per cent. of metallic iron 37.14.

IRON ORE from the Summit mine of the Lehigh, Northampton county.

Description.—Compact, nodular; fracture conchoidal; color slate blue; weathered surface rusty.

Composition in 100 parts:

Per oxide of iron,	21.40
Alumina,	18.60
Lime and magnesia,	traces
Water,	4.00
Carbonic acid,	traces
Silica and insoluble matter,	55.65
Loss,	0.35
	100.00

Per cent. metallic iron 14.98. This ore would gain 4 per cent. by roasting. Though carefully selected with a view to exhibit an average of the ore in the bed, we may perhaps have chosen a specimen a little too poor.

IRON ORE from near Brighton, Beaver county.

Description.—Structure, concretionary; when broken, the outer crust is of a dull red color, the interior crystalline, translucent and grey. The interior undecomposed portion selected for analysis.

Composition in 100 parts:

Carbonate of iron,	43.89
Carbonate of manganese,	7.20
Carbonate of lime,	42.51
Carbonate of magnesia,	3.57
Insoluble matter,	0.40
Water,	2.43
	100.00

This specimen is a highly calcareous ore, and would be rendered much richer by roasting. It contains 20.79 per cent. metallic iron.

IRON ORE from Robinson's farm, near Georgetown, Mercer county.

Description.—Compact; color dark blue; under the microscope exhibits innumerable, shining, crystalline points.

Composition in 100 *parts:*

Carbonate of iron,	84.24
Carbonate of manganese,	1.33
Carbonate of lime,	4.38
Alumina,	0.89
Silica and insoluble matter,	7.06
Water and some carbonaceous matter,	2.10
Sulphur,	a trace
	100.00

This specimen contains 39.93 per cent. metallic iron.

Iron Ore from Mount Eagle, Black Spring gap, Dauphin county.

Description.—Structure slaty, with rhomboidal fracture; color dull, nearly black.

Composition in 100 *parts:*

Carbonate of iron,	73.94
Per oxide of iron,	10.36
Carbonate of manganese,	2.95
Carbonate of magnesia,	2.07
Water,	1.99
Carbonaceous matter,	1.54
Silica and insoluble matter,	6.63
Loss,	0.52
	100.00

This specimen contains 42.22 per cent. metallic iron.

Iron Ore from half a mile west of Lockport, Westmoreland county.

Description.—Compact, close grained, somewhat crystalline in portions, sparry; fracture slightly conchoidal; color slate blue.

Composition in 100 parts:

Carbonate of iron,	45.30
Carbonate of lime,	32.00
Carbonate of magnesia,	4.50
Carbonate of manganese,	2.30
Alumina,	1.25
Water,	6.00
Silica and insoluble matter,	9.45
Loss,	0.30
	100.00

This specimen contains 21.86 per cent. metallic iron; it would gain considerably in richness by roasting, being chiefly a carbonate of iron and carbonate of lime.

Iron Ore from upper stratum, 8 to 9 inches thick, Lockport, Westmoreland county.

Description.—Nodular, close grained; fracture conchoidal; dove color.

Composition in 100 parts:

Carbonate of iron,	69.00
Carbonate of lime,	7.80
Carbonate of magnesia,	a trace
Alumina,	a trace
Silica and insoluble matter,	20.44
Water,	2.40
Loss,	0.36
	100.00

This ore contains 33.32 per cent. metallic iron.

Iron Ore from Lockport, Westmoreland county. Bog ore.

Description.—Texture porous, friable; rich ochre brown, internally chesnut brown; includes delicate vegetable fibres.

Composition in 100 *parts:*

Per oxide of iron,	77.00
Oxide of manganese,	4.50
Alumina,	0.50
Organic matter,	1.22
Water,	12.00
Silica and insoluble matter,	4.00
Loss,	0.28
	100.00

This specimen contains 53.90 per cent. metallic iron.

Iron Ore from first band of Warner's, Iron Run, Bennett's branch, Clearfield county.

Description.—Structure distinctly oolitic, grains small; color light grey, mottled brown, and somewhat glimmering. Interior of specimen taken for analysis.

Composition in 100 *parts:*

Carbonate of iron,	55.82
Carbonate of lime,	5.00
Alumina,	a trace
Silica and insoluble matter,	36.80
Water,	2.00
Loss,	0.38
	100.00

This specimen contains 26.95 per cent. metallic iron.

Iron Ore from the same locality, but higher up Warner's, Bennett's branch of the Simmemahoning, Clearfield county.

Description.—Structure nodular, concentric; aspect earthy; color dull blue; surface ochreous.

Composition in 100 *parts:*

Carbonate of iron,	73.81
Per oxide of iron,	4.24
Alumina,	1.00
Lime and manganese,	traces
Organic matter,	0.50
Water,	5.50
Silica and insoluble matter,	14.46

This specimen contains 38.59 per cent. metallic iron.

IRON ORE from Canal, one mile above Blairsville, Westmoreland county.

Description.—Compact, coarse grained, semi-crystalline; color bluish grey.

Composition in 100 *parts:*

Carbonate of iron,	71.19
Carbonate of lime,	3.50
Carbonate of magnesia,	2.72
Alumina,	2.10
Silica and insoluble matter,	17.55
Water,	2.70
Loss,	0.24
	100.00

Per cent. of metallic iron 34.37.

IRON ORE from same locality as above; different variety.

Description.—Structure nodular, fracture conchoidal, compact; dove colored, surface ochreous and smooth.

Composition in 100 *parts:*

Carbonate of iron,	67.20
Per oxide of iron,	7.48
Carbonate of lime,	3.24
Carbonate of magnesia,	1.50
Alumina,	a trace.
Water,	8.00
Silica and insoluble matter,	12.34
Loss,	0.24
	100.00

Per cent metallic iron 37.24.

Iron Ore from Limestone run, above limestone stratum, on Warner's, Bennett's branch of the Sinnemahoning, Clearfield county.

Description.—Structure flat, kidney shaped masses, concentric; somewhat crystalline; color blue grey.

Composition in 100 *parts:*

Carbonate of iron,	55.10
Per oxide of iron,	9.50
Alumina,	2.10
Carbonate of lime,	5.80
Carbonate of magnesia,	5.40
Silica and insoluble matter,	18.90
Water,	2.00
Loss,	0.20
	100.00

Per cent. metallic iron 34.72.

Iron Ores from Shamokin Coal Company's lands, four different varieties.

Description.—First variety: Compact, close grained, hard; fracture somewhat slaty; color dark blue; surface rusty.

Composition in 100 *parts:*

Carbonate of iron,	56.90
Per oxide of iron,	24.90
Alumina,	1.00
Lime and manganese,	traces
Silica and insoluble matter,	16.05
Water,	1.50
Loss,	0.15
	100.00

Per cent. metallic iron, 44.87.

Description.—Second variety: Massive, close grained; fracture somewhat conchoidal; surface glazed; color dull bluish black.

Composition in 100 parts:

Carbonate of iron,	74.50
Carbonate of lime,	5.40
Carbonate of magnesia,	a trace
Corbonate of manganese,	a trace
Alumina,	2.80
Silica and insoluble matter,	14.30
Water,	2.50
Loss,	0.50
	100.00

This specimen contains of metallic iron 35.98 per cent.

Description.—Third variety: Nodular, coarse grained, a little crystalline; color blue grey.

Composition in 100 parts:

Carbonate of iron,	63.20
Carbonate of lime,	1.00
Carbonate of magnesia,	a trace
Alumina,	1.50
Silica and insoluble matter,	31.15
Water,	2.50
Loss,	0.65
	100.00

Metallic iron 30.52 per cent.

Description.—Fourth variety: Kidney ore; nodular, flattened masses; texture compact; surface rusty, internally slate blue.

Composition in 100 parts:

Carbonate of iron,	58.00
Per oxide of iron,	8.45
Carbonate of lime,	a trace
Carbonate of magnesia,	a trace
Carbonate of manganese,	4.50
Alumina,	4.50
Organic matter,	1.50
Silica and insoluble matter,	15.44
Water,	7.50
Loss,	0.11
	100.00

Per cent metallic iron 45.92.

Iron Ore from mountain near Shamokin Iron Works.

Description.—Structure porous, cellular, brittle; color rich light chesnut brown.

Composition in 100 *parts:*

Per oxide of iron,	79.50
Alumina,	a trace
Oxide manganese,	a trace
Organic matter,	2.50
Water,	12.50
Silica and insoluble matter,	4.80
Loss,	0.70
	100.00

Per cent. metallic iron 55.65.

Iron Ore from forks of Paint creek, three miles above mouth of Stoney creek, Cambria county.

Description.—Structure flattened, nodular, compact; color slate blue; color light buff.

Composition in 100 *parts:*

Carbonate of iron,	60.90
Per oxide of iron,	12.60
Carbonate of lime,	3.00
Alumina,	2.00
Silica and insoluble matter,	14.74
Water,	6.50
Loss,	0.26
	100.00

Per cent. metallic iron 38.22.

Iron Ore from near the conglomerate, at Karthaus, Clearfield creek, one mile S. of Squire Warner's.

Description.—Nodular, concentric; crust hematitic; nucleus filled with sparry iron and pulverulent oxide; color mottled chesnut brown; lustre glimmering.

Composition in 100 parts:

Carbonate of iron,	19.86
Per oxide of iron,	34.80
Carbonate of lime,	4.50
Alumina,	1.70
Silica and insoluble matter,	30.40
Manganese,	a trace
Water,	8.20
Loss,	0.54
	100.00

Per cent. metallic iron 33.95.

Iron Ore from run west of Clearfield creek, two miles above mouth, on Mr. Wilson's land, Clearfield county.

Description.—Structure somewhat nodular; outside friable, inside more compact; color mottled grey; contains sparry iron.

Composition in 100 parts:

Carbonate of iron,	50.48
Per oxide of iron,	12.79
Carbonate magnesia, with a trace of carbonate of manganese,	2.43
Carbonate of lime,	0.70
Insoluble matter,	29.01
Water,	4.59
	100.00

Per cent. metallic iron 32.77.

Iron Ore three miles above Clearfield on river bank, Clearfield county.

Description.—Moderately compact, semi-crystalline; color dark blue, outside rusty.

Composition in 100 *parts:*

Carbonate of iron,	56.83
Per oxide of iron,	13.21
Carbonate of manganese,	1.13
Carbonate of magnesia,	1.26
Alumina,	a trace
Insoluble matter,	24.41
Water,	3.16
	100.00

Per cent. metallic iron 36.11.

IRON ORE, a variety of the above and from the same locality.

Description.—Nodular, compact—when broken exhibiting small cavities coated with drusy quartz and iron pyrites, in minute cubical crystals; color of mass dull blue. The portion selected for analysis was taken from the more compact and homogeneous part in which no specks of pyrites could be observed.

Composition in 100 *parts:*

Carbonate of iron,	66.37
Per oxide of iron,	20.49
Carbonate of manganese,	2.25
Carbonate of lime,	1.07
Carbonate of magnesia,	2.08
Alumina,	a trace
Sulphur,	a trace
Water,	1.64
Silica and insoluble matter,	6.10
	100.00

Per cent. metallic iron 45.64.

IRON ORE from Buffalo creek, Horner's mill, Armstrong county.

Description.—Nodular, or ball ore, compact, close grained; color interior brownish blue, exterior brown.

Composition in 100 *parts:*

Carbonate of iron,	68.32
Carbonate of lime,	15.54
Carbonate of magnesia,	1.35
Carbonate of manganese,	a trace
Alumina,	a trace
Insoluble matter,	10.58
Water,	4.00
Loss,	0.21
	100.00

Per cent. metallic iron 32.95.

Iron Ore from same locality as above, but more siliceous.

Composition in 100 *parts:*

Carbonate of iron,	54.33
Carbonate of lime,	a trace
Carbonate of magnesia,	a trace
Alumina,	0.50
Insoluble matter,	40.90
Water,	4.00
Loss,	0.27
	100.00

Per cent. metallic iron 25.34.

From the statements above given of the composition of our iron ores, including the characteristic varieties from nearly all the ore bearing formations in the state, it would appear that they belong chiefly to three distinct species: *magnetic iron ore, brown oxide of iron,* and *compact carbonate of iron,* the two latter kinds being much the most extensively diffused. The magnetic ores occur only in the south-eastern division of the state, either among the primary rocks or adjacent to the trap dykes of the middle secondary region. The compact carbonate of iron, being the ore which in nearly all countries is confined principally to the coal formation, abounds mainly in our anthracitic and bituminous coal measures, where it exists in many of the basins in a quantity truly inexhaustible. The extensive and valuable deposite situated in the bottom layers of F. VIII., in Franklin, Huntingdon and Juniata counties, which was proved by us to be a regular and continuous deposite, is also a variety of the compact carbonate of iron, though, like the similar ore of the coal measures, it passes into the per oxide at its outcrop.

The other class of ores, varieties of the brown oxide or per oxide of iron, prevail on the other hand in greater or less abundance in all the formations within the State, valuable deposites occurring in association not only with many of the older secondary rocks of the Appalachian region, but likewise with the gneiss and marble of the primary district on the one side and the coal measures on the other.

In presenting the foregoing analyses, it is requisite to remind the reader that the different ores here described will not retain the same relation to each other as respects the per centage of iron in them after they have undergone the usual roasting preparatory to entering the furnace, the carbonates losing much more extraneous matter by this process than the per oxide ores. The chief volatile constituent in the latter class, it will be seen, is *water*, which seldom amounts to fifteen per cent. upon the raw ore, whereas in the other class, besides a small quantity of water, there prevails, varying with the richness of the ore, a large proportion of carbonic acid gas, much of which is extricated during the preliminary roasting. Thus if we omit the consideration of the gain from detaching the externally adhering soil and other matters, the one species will not often improve, by roasting, in richness more than five or seven per cent. while the other class will sometimes exhibit an improvement of as much as ten or twelve per cent.

It should be remarked that all forms of the carbonate of iron show a natural tendency to loose their carbonic acid and pass to the condition of the brown or per oxide of iron by exposure to atmospheric agencies. Such ores will therefore be considerably richer in iron at their outcrop than a few feet in from the surface. Inattention to this point is a fertile source of mistake, in estimating the average product of beds of ore discovered in the coal measures. We observe a similar increase in richness at its outcrop in the calcareous, fossiliferous ore of F. V., but this arises from the solution and removal by percolation of the carbonate of lime which is an important ingredient in the harder varieties of this ore. In it the iron is already in the state of the red per oxide, not of a carbonate of iron.

VII. *Analysis of a Zinc and Lead Ore.*

Analysis of an impure silicate of zinc from the bank of the Susquehanna, opposite Selinsgrove, Northumberland county.

Description.—Occurs in irregular amorphous shaped masses, of an earthy and sometimes semi-crystalline appearance, containing disseminated portions of sulphuret of lead, which are embedded in a greyish, imperfectly crystallized silicate of zinc. An average portion of a large mass furnished in the 100 parts

Oxide of zinc, - - - - - -	60.50
Sulphuret of lead, - - - - - -	10.00
Oxide of iron and alumina, - - -	0.50
Silica, - - - - - - - -	23.00
Water, - - - - - - - -	5.60
Loss, - - - - - - - -	0.40
	100.00

This ore contains of metallic zinc 50.40, and of metallic lead 8.66.

VIII. *Analyses of Cast Iron.*

Cast Iron made in the summer of 1839, at Farrandsville, from two parts Larry's creek ore and two and a half parts Catawissa ore and five parts limestone.

Description.—Minutely granular and of uniform texture throughout; color bluish grey. So tough under the hammer as to be difficult to break into small pieces.

Composition in 100 *parts:*

Pure iron, - - - - - - -	93 91
Silicium, - - - - - - -	2.40
Manganesium, - - - - - -	0.07
Aluminium, - - - - - - -	0.50
Carbon, - - - - - - -	3.12
Sulphur, - - - - - -	a trace
	100.00

CAST IRON from Danville.

Description.—Texture soft, brilliantly crystalline; grey.

Composition in 100 *parts:*

Pure iron, - - - - - - -	94.94
Silicium, - - - - - -	2.03
Manganesium, - - - - - - -	0.05
Aluminium, - - - - - - -	a trace
Carbon, - - - - - - - -	2.98
	100.00

SECTION II.

ANALYSES OF COALS.

I. *Anthracite Coals.*

COAL from Nesquehoning mines, from the 10th feet vein, east drift, Northampton county. Structure irregularly columnar; fracture irregularly conchoidal; color greyish black; lustre splendent.

Composition in 100 *parts:*

Volatile matter, - - - - - - -	6.40
Carbon, - - - - - - -	86.60
Ashes, white, - - - - - - -	7.00
	100.00

COAL from Summit mines of the Lehigh Company, from a vein said to be 14 feet thick, Northampton county. Structure massive, compact; color black, metallic; lustre brilliant.

Composition in 100 *parts:*

Volatile matter, - - - - -	7.50
Carbon, - - - - - - -	88.50
Ashes, dull white, - - - - -	4.00
	100.00

Coal from Summit mines, Lehigh Company, Northampton county, hardest variety. Structure dense, laminated; fracture smooth, somewhat conchoidal; color metallic black; lustre splendent.

Composition in 100 *parts:*

Volatile matter, - - - - - - -	6.60
Carbon, - - - - - - - -	87.70
Ashes, white, - - - - - - - - -	5.70
	100.00

Coal from Tamaqua coal mines on east side of the river, called vein D east, Schuylkill county. Texture nearly compact, somewhat slaty; fracture conchoidal; greyish or iron black; lustre splendent. Specific gravity 1.57.

Composition in 100 *parts:*

Volatile matter, - - - - - - -	5.03
Carbon, - - - - - - - -	92.07
Ashes, white, - - - - - - - -	2.90
	100.00

Coal from Tamaqua mines, vein E east, Schuylkill county. Texture compact; fracture conchoidal; greyish black; lustre splendent. Specific gravity 1.60.

Composition in 100 *parts:*

Volatile matter, - - - - -	4.54
Carbon, - - - - - - - -	89.20
Ashes, perfectly white, - - - - -	6.26
	100.00

Coal from Tamaqua coal mines, R. vein, in the Sharp mountain. Texture compact, tendency to lamination; greyish black; lustre metallic, splendent. Specific gravity 1.55.

Composition in 100 *parts:*

Volatile matter,	7.55
Carbon,	87.45
Ashes, white,	5.10
	100.00

Coal from Tuscarora mines, from second drift south of Jackson's mine, Schuylkill county. Structure slightly laminated, tolerably compact; irregular conchoidal fracture; color black; lustre splendent.

Composition in 100 *parts:*

Volatile matter,	7.50
Carbon,	88.20
Ashes, pinkish brown,	4.30
	100.00

Coal from the Schenoweth vein, Pottsville, Schuylkill county. Structure compact; irregular fracture; color black; lustre splendent. Specific gravity 1.50.

Composition in 100 *parts:*

Volatile matter,	1.40
Carbon,	94.10
Ashes, light brown,	4.50
	100.00

Coal from Neeley's Tunnel, third vein, Schuylkill county. Texture compact; iron black; fracture conchoidal; lustre splendent. Sp. gr. 1.55.

Composition in 100 *parts:*

Volatile matter,	5.40
Carbon,	89.20
Ashes, light yellow color,	5.40
	100.00

Coal from Sharp mountain, Pinegrove. Texture laminated; grey black; fracture splintery; lustre splendent. Sp. gr. 1.54.

Composition in 100 *parts:*

Volatile matter,	7.15
Carbon,	80.57
Ashes,	3.28
	100.00

Coal from Black Spring Gap, Dauphin county, twenty-five miles east of the river. Massive, friable; fracture irregular; color iron black; lustre somewhat splendent. Sp. gr. 1.44.

Composition in 100 *parts:*

Volatile matter,	9.53
Carbon,	82.47
Ashes, yellow white color,	8.00
	100.00

Coal from Lea vein, 7 feet thick, near Black Spring Gap, Dauphin county. Structure laminated, brittle, black, shining. Specific gravity 1.35.

Composition in 100 *parts:*

Volatile matter,	8.96
Carbon,	85.84
Ashes, cream color,	5.20
	100.00

Coal from Grey vein, 16.7 feet thick, near Black Spring Gap. Massive; fracture irregular; color black; considerable lustre.—Specific gravity 1.44.

Composition in 100 *parts:*

Volatile matter,	9.78
Carbon,	81.02
Ashes, light orange,	9.20
	100.00

Coal from Grey vein, near Black Spring Gap; included *grey band.* Structure somewhat fibrous, brittle; color grey black, smutty; dull metallic lustre. Specific gravity 1.33.

Composition in 100 *parts:*

Volatile matter,	11.40
Carbon,	81.40
Ashes, pale ochreous color,	7.20
	100.00

Coal from Peacock vein, Gold Mine Gap, Dauphin county, twenty-five miles east of the river. Structure massive, with a tendency to columnar fracture, angular; color black, shining, irised. Specific gravity 1.41.

Composition in 100 *parts:*

Volatile matter,	10.95
Carbon,	82.15
Ashes, light orange color,	6.90
	100.00

Coal from the Heister vein, Gold Mine Gap, Dauphin county. Structure massive; striæ distinct; color jet black; lustre shining. Specific gravity 1.41.

Composition in 100 *parts:*

Volatile matter,	10.43
Carbon,	81.47
Ashes, pale yellow color,	8.10
	100.00

Coal from vein supposed to be the Peacock vein, W. side of Raush Gap, Dauphin county, twenty-one miles east of the river. Structure massive, friable, small columnar; fracture irregular; color black; iridescent. Specific gravity 1.45.

Composition in 100 *parts:*

Volatile matter,	10.57
Carbon,	77.23
Ashes, pale orange,	12.30
	100.00

Coal from Yellow Spring Gap, Dauphin county, sixteen miles east of the Susquehanna. Structure slaty, somewhat brittle; fracture irregular; black; lustre shining. Specific gravity 1.41.

Composition in 100 *parts:*

Volatile matter,	10.95
Carbon,	79.55
Ashes, pale yellow color,	9.50
	100.00

Mr. R. C. Taylor gives an analysis of a coal from Yellow Spring Gap, which contains 14.80 per cent. of volatile matter. Consult two reports on this part of the basin by Richard C. Taylor, 1840.

Coal from Rattling run, Dauphin county, thirteen miles east of the river. Massive, regular fracture, tendency to lamination, cross fracture shining, black; between the laminæ, lustre feeble.

Composition in 100 *parts:*

Volatile matter,	13.75
Carbon,	74.55
Ashes in the coal,	11.70
	100.00

Coke light and spongy.

Coal from Big flats, Dauphin county, nine miles east of the river from the shaft. Massive, irregularly laminated; fracture irregular; striæ small and distinct; jet black and considerable lustre.

Composition in 100 *parts:*

Volatile matter,	15.06
Carbon,	76.94
Ashes, orange,	8.00
	100.00

Makes good coke.

Coal from Lykens Valley, third bed, Dauphin county. Texture, laminated, brittle; fracture fibrous; color jet black, shining.

Composition in 100 *parts:*

Volatile matter,	8.85
Carbon,	88.25
Ashes,	2.90
	100.00

Coal from Shamokin coal mines, Snyder's mine. Structure massive, compact; fracture laminated; beautifully iridescent.

Composition in 100 *parts:*

Volatile matter,	6.10
Carbon,	89.90
Ashes,	4.00
	100.00

Coal from Wilkesbarre, Luzerne county, Warden's vein. Texture compact, iron black; lustre, splendent; fracture conchoidal. Specific gravity, 1.403.

Composition in 100 *parts:*

Volatile,	7.68
Carbon,	88.90
Ashes,	3.49
	100.00

Coal from Wilkesbarre coal basin, Carbondale mines, Luzerne county. Texture laminated; laminæ compact; iron black; fracture somewhat irregular; lustre brilliant, metallic. Specific gravity 1.404.

Composition in 100 *parts:*

Volatile matter,	7.07
Carbon,	90.23
Ashes, greyish,	2.70
	100.00

The first twenty analyses of the foregoing series, will exhibit the average composition of the coal in the different parts of the first, or great southern anthracite basin, the specimens which were selected with this view having been chosen from various localities, at tolerably regular intervals from near its eastern extremity to within a few miles of its western termination. The public is already familiar with the fact of the general increase of softness in the coal of this basin as we proceed westward. The above results will display a similar augmentation in the quantity of the volatile materials in the coal, though it does not follow that these two features are in exact proportion to each other, as a single neighborhood will shew beds of coal differing considerably in both these particulars the hardness and volatile matter, and where no such dependence of the one upon the other can be remarked. I reserve for a future occasion the more full discussion of this curious subject, of the gradations noticeable in the character of the coal in many of our coal fields, confining myself at present to the striking variation which occurs towards the western extremity of this southern anthracite basin.

From the Lehigh westward as far as the Swatara, we rarely find the volatile matter to amount to more than about *seven and a half per cent.* in the coal, while its *average* quantity in our anthracite generally may be stated at about *six per cent*; nearly the whole of this appears to be water. Advancing a few miles west of the Swatara, we enter a section of the basin where the coal acquires a decided increase in the amount of its volatile matters. At Black Spring Gap, twenty-six miles east of the Susquehanna, this is first distinctly manifested, the quantity there being about *ten* per cent. A portion of this is probably free gaseous matter, not bitumen, or if this is present the quantity is too small to impart to the coal any tendency to melt or make a coke. But about ten miles further westward, we meet with coal, in the prolongation of the very same veins, having as much as from *ten* to *fifteen* per cent. of volatile matter, and a part of this obviously bitumen. From the Yellow Spring gap to the western extremity of the basin, the largest proportion of volatile matter which we have yet noticed in the coal is about *fifteen* per cent. Where it possesses this amount it has all the properties of a true bituminous coal, burning with a brilliant, though not very enduring blaze, and yielding, when properly treated, a good spongy coke, well adapted to manufacturing purposes.

II. Bituminous Coals.

Broad Top Basin.

Coal from Hopewell Furnace mines, Broad Top mountain, Bedford county. Massive, striæ distinct, somewhat columnar, shining jet black, in parts iridescent.

Analysis in 100 *parts:*

Volatile matter, - - - - -	11.20
Coke, - - - - - - - -	88.80
	100.00

Ashes in the coal, 4.00.

Coke spongy but hard.

The coal of the Broad Top basin exhibits an interesting confirmation of the general law early noticed by me, that as we advance towards the N. W. the coals acquire more and more bitumen. This coal field, occupying a position intermediate between the range of the anthracite basins on the one hand and the bituminous basins beyond the Allegheny mountain on the other, its coal displays a corresponding or intermediate proportion of bitumen.

First Basin N. W. of the Allegheny Mountain.

Coal from bed of Lick run, Lycoming county. Laminated, somewhat brittle, shining black, between laminæ dull black.

Analysis in 100 *parts:*

Volatile matter, - - - - - - -	20.72
Coke, - - - - - - - -	79.28
	100.00

Ashes in the coal 13.07, greyish pink.

Coal from Queen's run, two miles below Farrandsville, Clinton county. Irregularly columnar, brittle; color jet black, shining with thin films of charcoal.

Analysis in 100 *parts:*

Volatile matter, - - - - -	21.50
Coke, - - - - - - -	78.28
	100.00

Ashes in the coal, 4.60.

Coal from Snow Shoe mine, Centre county. Massive, brittle, irregular fracture; tendency to columnar structure; lustre shining jet black.

Composition in 100 *parts:*

Volatile matter, - - - - - -	21.20
Coke, - - - - - - -	78.80
	100.00

Ashes in the coal, 2.07.

Coke highly intumescent and spongy.

Coal from Moshannon creek, near Philipsburg, Clearfield county. Structure small columnar, somewhat fibrous; striæ distinct; lustre jet black and shining.

Composition in 100 *parts:*

Volatile matter, - - - - -	29.50
Coke, - - - - - - -	70.50
	100.00

Ashes in the coal, 6.10.

Coal from Steed's mine, sixteen miles from Philipsburg, Centre county. Friable, irregularly columnar; striæ distinct; jet black, with considerable lustre.

Composition in 100 *parts:*

Volatile matter,	20.40
Coke,	79.60
	100.00

Ashes in the coal, 11.20.

Coke compact; ashes light cream color.

Coal from Leech's mine, seventeen and a half miles from Philipsburg, Centre county. Friable; structure columnar; jet black with much lustre.

Composition in 100 *parts:*

Volatile matter,	20.32
Coke,	79.68
	100.00

Ashes in the coal, 11.75.

Second Basin N. W. of the Allegheny Mountain.

Coal from upper part of large bed, Ralston, Lycoming county. Columnar, irregular cubical; fracture irregular; color shining black, in parts dull.

Composition in 100 *parts:*

Volatile matter,	20.50
Coke,	79.50
	100.00

Ashes in the coal, 5.00.

Coal from Karthaus, upper seam, Clearfield county. Structure columnar, cubical, friable; fracture irregular; color jet black; lustre considerable.

Composition in 100 *parts:*

Volatile matter,	13.00
Coke,	87.00
	100.00

Ashes in the coal, 8.80 brownish yellow.

Coal from Karthaus, lower seam. External characters similar to the above.

Composition in 100 *parts:*

Volatile matter,	24.80
Coke,	75.20
	100.00

Ashes in the coal, 4.70, brownish yellow.

Coal from Reed's, six feet vein, Curwinsville, Clearfield county. Columnar, cubical, brittle; fracture irregular; color jet black with great lustre.

Composition in 100 *parts:*

Volatile matter,	27.00
Coke,	73.00
	100.00

Ashes in the coal, 5.30.

Third Basin N. W. of the Allegheny Mountain.

Coal from the bed now worked at Bear creek, Blossburg, Tioga county. Columnar, somewhat compact, containing occassional thin seams of charcoal; lustre jet black and very considerable.

Composition in 100 *parts:*

Volatile matter,	32.00
Coke,	68.00
	100.00

Ashes in the coal 5.20.

Coal from five feet vein, Warner's, Caledonia, Clearfield county. Structure laminated, cubical, brittle; fracture irregular; color jet black and shining.

Composition in 100 *parts:*

Volatile matter,	37.00
Coke,	63.00
	100.00

Ashes in the coal 8.50.

Coal from three feet seam, Warner's, Caledonia, Clearfield county. Soft, columnar; lustre jet black and very considerable; fracture irregular.

Composition in 100 *parts:*

Volatile matter,	38.20
Coke,	61.80
	100.00

Ashes in coal, 7.20.

Coal from Blairsville, large bed, Westmoreland county. Structure laminated, columnar, somewhat hard and compact; color shining jet black.

Composition in 100 *parts:*

Volatile matter,	31.00
Coke,	69.00
	100.00

Ashes in the coal, 4.00.

Fourth or great Western Basin.

Coal from Sandy ridge, four miles from Shippensville, Clarion county. Massive; striæ indistinct; fracture cubical; black; lustre feebly shining.

Composition in 100 *parts:*

Volatile matter,	43.20
Coke,	56 80
	100.00

Ashes in the coal 7.00; light grey.

Cannel Coal from six miles east of Franklin, Venango county. Composed of laminæ, breaks with a uniform cleavage; cross fracture conchoidal; surface smooth, dull black, with little lustre.

Composition in 100 *parts:*

Volatile matter,	52.78
Coke,	47.22
	100.00

Ashes in the coal 17.68.

Cannel Coal from Greersburg, Beaver county. Composed of thick regular laminæ; cross fracture conchoidal; surface smooth, dull black.

Composition in 100 *parts:*

Volatile matter,	36.00
Coke,	64.00
	100.00

Ashes in the coal 33.88.

Coal from Conneaut Lake, Crawford county. Slaty, laminated; fracture irregular; somewhat brittle; color jet black shining.

Composition in 100 *parts:*

Volatile matter,	38.75
Coke,	61.25
	100.0

Ashes in the coal 1.80 reddish brown.

Coal from near Greenville, Mercer county. Laminated, slaty; cross fracture splintery; brittle; color shining jet black.

Composition in 100 *parts:*

Volatile matter,	40.50
Coke,	59.50
	100.00

Ashes in the coal 1.7 brownish yellow.

Coal from near Orangeville, Mercer county. Structure laminated; somewhat rusty between laminæ; fracture regular; color black, sometimes shining and iridescent.

Composition in 100 *parts:*

Volatile matter, - - - - - -	43.75
Coke, - - - - - - - - -	56.25
	100.00

Ashes in the coal 2.80 dark brown.

A comparison of the foregoing analyses of the bituminous coals from the several basins northwest of the Allegheny mountain, discloses the highly interesting general fact of the progressive increase in the quantity of their bitumen, as we advance northwestward. Thus, the first group of coals selected from various parts of the basin nearest the Allegheny mountain, shows an average proportion of bitumen of about *twenty-one* per cent; the second or next basin to the N. W. a somewhat higher proportion; the third basin or range of basins gives as much as *thirty-four* per cent; and the fourth or great western basin of the Allegheny and Monongahela, nearly *forty* per cent.

This remarkable change in the composition of the coal as we proceed from the S. E. to the N. W. is not confined only to the basins of Pennsylvania, but prevails, I have reason to believe, throughout the whole length of the vast bituminous coal field which ranges from our State to the northern boundary of Alabama. I defer to a future opportunity an inquiry into the circumstances which formed and subsequently modified this truly prodigious deposite of carbonaceous matter.

Sulphur.—All the varieties of coal contain more or less *sulphur*, no doubt in combination with iron, under the form of iron pyrites disseminated throughout the coal. The amount of this substance materially influencing the value of different coals, when applied to metallurgic or other economic uses, it has been deemed advisable to make a series of comparative experiments to ascertain the proportions in which it exists in the two most widely different varieties of our coal, the anthracite and bituminous. From numerous chemical examinations made in reference to the point, the following results are selected. The specimens were clean and free from any adhering slaty matter.

Anthracite Coal from Pottsville, average specimen of white ash:
Contains in 100 parts—Sulphur, - - - 0.60

Anthracite Coal from Peach mountain, average specimen of red ash:
Contains in 100 parts—Sulphur, - - - 0.48

Anthracite Coal from Lehigh, (hard coal,) average specimen of white ash:
Contains in 100 parts—Sulphur, - - - 0.91

Bituminous Coal from Karthaus, highly bituminous:
Contains in 100 parts—Sulphur, - - - 2.70

Bituminous Coal Blairsville, Westmoreland county:
Contains in 100 parts—Sulphur, - - - 2.60

Analyses of Limestones.

It will be seen from the following analyses that a large portion of our limestones contain a considerable amount of *magnesia*. Though it is now satisfactorily ascertained that the presence of this earth in lime does not in any way interfere with its useful properties when employed as a fertilizing agent, its hurtfulness as a *flux* in the process of making iron is well established.

Aware of the very frequent oversights committed by the proprietors of our numerous iron works in using magnesian in place of pure limestone, and apprized by experience of the extreme difficulty of distinguishing the fit varieties from the unfit by their appearance merely, I shall endeavor in my final report to produce an extensive series of chemical analyses of the limestones employed at the various furnaces. At present I offer a few results, more with a view to draw the attention of iron masters to this too much neglected subject of magnesia, than with the desire to exhibit a large body of analyses, for which there is not space in the limits of an annual report.

Limestones from Formation II.

Limestone from Mr. Keller's quarry, below Easton. Color bluish grey; compact, close grained, semi-crystalline; fracture slightly conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime, - - - - - -	51.02
Carbonate of magnesia, - - - - -	43.28
Alumina and oxide of iron, - - -	0.50
Insoluble matter, - - - - - -	4.80
Water and loss, - - - - - -	0,40
	100.00

Limestone from Hepburn and Able's quarry, below Easton. Color light grey; compact; texture fine grained; fracture irregularly conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime, - - - - -	55.00
Carbonate of magnesia, - - - - -	31.40
Alumina and oxide of iron, - - -	2.30
Insoluble matter, - - - - - -	10.80
Water, - - - - - - - -	0.50
	100.00

Limestone from Judge Porter's quarry, on the Delaware below Easton. Color dark bluish grey; compact; moderately fine texture, sub-crystalline; fracture sharp conchoidal.

Composition in 100 *parts:*

Carbonate of lime, - - - - - -	48.30
Carbonate of magnesia, - - - - -	42.15
Alumina and oxide of iron, - - - -	4.30
Insoluble matter, - - - - - -	4.80
Water, - - - - - -	0.45
	100,00

Limestone from Judge Porter's farm, south of Easton. Color dull bluish grey; compact, close grained; fracture irregular; weathered surface ochreous.

Composition in 100 *parts:*

Carbonate of lime,	34.10
Carbonate of magnesia,	37.90
Alumina and oxide of iron,	1.30
Insoluble matter,	26.30
Water,	0.40
	100.00

Limestone from Mr. Shrie's, four miles below Easton. Color grey; texture moderately compact, sub-crystalline; fracture somewhat even; angles sharp.

Composition in 100 *parts:*

Carbonate of lime,	48.70
Carbonate of magnesia,	41.76
Alumina and oxide of iron,	1.30
Insoluble matter,	7.80
Water,	4.40
	100.00

Limestone from Harman's quarry, four miles below Easton. Color grey; texture sub-crystalline; fracture irregular, angular.

Composition in 100 *parts:*

Carbonate of lime,	50.80
Carbonate of magnesia,	47.10
Alumina and oxide of iron,	0.50
Insoluble matter,	1.00
Water,	0.50
Loss,	0.10
	100.00

Limestone from near Biery's bridge, on Lehigh river, used as flux in the Lehigh Crane Iron works; color greyish blue; texture compact, fine grained; sub-crystalline; fracture slightly conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime,	52.70
Carbonate of magnesia,	33.78
Alumina and oxide of iron,	2.80
Insoluble matter,	10.30
Water,	0.42
	100.00

Limestone from near Biery's bridge, three miles above Allentown, Lehigh county, used as a flux in the Crane iron works. Color grey; texture distinctly crystalline and sparry; fracture irregular.

Composition in 100 *parts:*

Carbonate of lime,	93.40
Carbonate of magnesia,	none
Alumina and oxide of iron,	1.80
Insoluble matter,	4.30
Water,	0.50
	100.00

Limestone used in Trexler furnace, Lehigh county. Color light grey; moderately compact and fine grained; intersected by veins of white calc spar; fracture somewhat conchoidal, angles sharp.

Composition in 100 *parts:*

Carbonate of lime,	50.30
Carbonate of magnesia,	41.30
Alumina and oxide of iron,	3.80
Insoluble matter,	4.30
Water,	0.30
	100.00

Limestone from Davy Shall's quarry, near his forge, west branch of Perkiomen creek, Berks county. Color dull light grey, sub-crystalline; compact; fracture angular.

Composition in 100 *parts:*

Carbonate of lime,	53.17
Carbonate of magnesia,	43.90
Alumina and oxide of iron,	0.70
Insoluble matter,	1.95
Water and loss,	0.28
	100.00

Limestone from George Keim's quarry, Pike township, Berks county. Color light bluish grey; structure somewhat laminated; texture sub-crystalline; fracture angular; contains in some parts small crystalline nodules of fluor spar; part analysed free from these.

Composition in 100 *parts:*

Carbonate of lime,	88.34
Carbonate of magnesia,	7.80
Alumina and oxide of iron,	0.24
Insoluble matter,	2.81
Water,	0.80
Loss,	0.01
	100.00

Limestone from eastern part of the town of Carlisle. Light dove color; very compact, and fine grained, disposed in regular laminæ; fracture very slightly conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	92.74
Carbonate of magnesia,	none
Alumina and oxide of iron,	1.00
Insoluble matter,	5.80
Water,	0.40
Loss,	0.06
	100.00

Limestone from near New Market, half a mile below Yellow Breeches creek, Cumberland Valley. Color dark grey; texture compact, sub-crystalline; fracture irregular, angular.

Composition in 100 *parts:*

Carbonate of lime,	92.83
Carbonate of magnesia,	none
Alumina and oxide of iron,	1.00
Insoluble matter,	5.80
Water,	0.37
	100.00

Limestone used as a flux in Mary Ann furnace, Cumberland county. Color light; texture moderately close, semi-crystalline; fracture irregular.

Composition in 100 *parts:*

Carbonate of lime,	89.61
Carbonate of magnesia,	9.45
Alumina and oxide of iron,	traces
Insoluble matter,	1.49
Water,	0.45
	100.00

Limestone used as a flux in Carlisle iron works. Color light blue; compact, slightly laminated; fracture sharp angular.

Composition in 100 *parts:*

Carbonate of lime,	78.37
Carbonate of magnesia,	none
Alumina and oxide of iron,	0.40
Insoluble matter,	20.80
Water,	0.43
	100.00

Limestone from railroad, quarter of a mile north-east of Shippensburg, Cumberland county. Color light dove; texture very close and fine grained; fracture smooth conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime,	87.20
Carbonate of magnesia,	none
Alumina and oxide of iron,	traces
Insoluble matter,	12.30
Water,	0.30
Loss,	0.20
	100.00

Limestone from one mile north from Mercersburg, Franklin county. Color light dove; texture compact, close grained, intersected by minute veins of white calc-spar; fracture somewhat conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime,	46.10
Carbonate of magnesia,	39.49
Alumina and oxide of iron,	2.60
Insoluble matter,	11.30
Water,	0.51
	100.00

Limestone from south-east of Waynesburg, Franklin county. Color dark grey; moderately fine grained, sub-crystalline; fracture harsh, conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	86.50
Carbonate of magnesia,	none
Alumina and oxide of iron,	4.80
Insoluble matter,	8.30
Water	0.40
	100.00

Limestone: white marble from three miles south-east of Waynesburg, Rogers's quarry, above Stoner's mill, Cumberland valley, Franklin county. Color cream white; texture beautifully compact and fine grained, exhibiting a very minute crystalline structure; fracture tendency to conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	98.80
Carbonate of magnesia,	none
Alumina and oxide of iron,	0.80
Insoluble matter,	a trace
Water,	0.40
	100.00

Limestone used at Pond furnace, (Moore's,) Franklin county. Color dark blue; texture compact and fine grained; fracture conchoidal, angular, occasionally exhibits extremely minute crystals of yellow iron pyrites.

Composition in 100 *parts:*

Carbonate of lime,	36.50
Carbonate of magnesia,	26.20
Alumina and oxide of iron,	5.00
Sulphur,	a decided trace
Insoluble matter,	27.30
Water,	5.00
	100.00

Limestone used as a flux at Caledonia furnace, Franklin county. Color bluish grey; texture moderately fine grained, semi-crystalline; fracture irregularly slaty.

Composition in 100 *parts:*

Carbonate of lime,	74.69
Carbonate of magnesia,	23.52
Alumina and oxide of iron,	traces
Insoluble matter,	1.49
Water,	0.30
	100.00

LIMESTONE from four miles east of Chambersburg, near Gettysburg turnpike, tried as a flux in Caledonia furnace, but not found good. Color dull dark grey; texture coarse, and slightly sparry; fracture irregularly conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	79.63
Carbonate of magnesia,	17.40
Alumina and oxide of iron,	traces
Insoluble matter,	2.64
Water,	0.60
Excess,	0.27
	100.00

LIMESTONE used as a flux in Carrick furnace, Path Valley, Franklin county. Color dove; compact, fine grained, somewhat sparry in portions; fracture smooth conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	94.71
Carbonate of magnesia,	none
Alumina and oxide of iron,	traces
Insoluble matter,	4.94
Water,	0.35
	100.00

LIMESTONE from Kishacoquillas valley, at the Iron mine near Allenville, on the anticlinal axis. Color light blue, dull; compact; fracture conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	46.64
Carbonate of magnesia,	36.31
Alumina and oxide of iron,	0.91
Insoluble matter,	15.83
Water,	0.31
	100.00

LIMESTONE from near Springfield furnace, Huntingdon county, obtained about four hundred yards from the base of Lock mountain. Color dull dark blue; compact, fine grained, somewhat sparry; fracture conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	99.20
Carbonate of magnesia,	none
Alumina and oxide of iron,	0.50
Insoluble matter,	a trace
Water,	0.30
	100.00

LIMESTONE from same locality, five hundred yards from base of Lock mountain. Color light dove; compact fine grained; weathered surface light ochreous color; fracture large conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime,	52.20
Carbonate of magnesia,	34.50
Alumina and oxide of iron,	1.80
Insoluble matter,	11.30
Water,	0.20
	100.00

LIMESTONE from same locality, six hundred and fifty yards from the base of Lock mountain. Color light grey; compact, texture; moderately fine grained; weathered surface buff; fracture even, angular.

Composition in 100 *parts:*

Carbonate of lime,	54.80
Carbonate of magnesia,	35.30
Alumina and oxide of iron,	4.00
Insoluble matter,	5.60
Water,	0.30
	100.00

Limestone from same locality, eight hundred yards from base of Lock mountain. Color brownish grey; texture compact, moderately fine grained, somewhat sparry; fracture irregular, angular.

Composition in 100 *parts:*

Carbonate of lime,	47.83
Carbonate of magnesia,	36.77
Alumina and oxide of iron,	2.80
Insoluble matter,	12.30
Water,	0.30
	100.00

Limestone from F. V.

Limestone from thirty feet above the iron ore at Matilda furnace, two miles west of Newton Hamilton, Huntingdon county. Color blue; compact, sub-crystalline; fracture conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	85.26
Carbonate of magnesia,	4.67
Per oxide of iron,	1.97
Oxide of manganese,	a trace
Insoluble matter,	7.97
Water,	0.13
	100.00

Limestones from F. VI.

Limestone from neighborhood of Millhall, flux used at Farrandsville. Color mottled grey and white; sparry, somewhat saccharoidal; fracture irregular; few fossils.

Composition in 100 *parts:*

Carbonate of lime,	96.80
Carbonate of magnesia,	0.50
Alumina and oxide of iron,	traces
Insoluble matter,	2.30
Water,	0.40
	100.00

Limestone from Hopewell furnace, Bedford county, used as a flux. Color blue black; compact and close grained; fracture conchoidal fossiliferous.

Composition in 100 *parts:*

Carbonate of lime,	92.00
Carbonate of magnesia,	a trace
Oxide of iron and alumina,	a trace
Insoluble matter,	3.50
Water,	4.50
	100.00

Limestone from Loyalsock, near Williamsport, used as a flux at the Astonville furnace, Lycoming county. Color bluish black; compact; fracture conchoidal; fossiliferous.

Composition in 100 *parts:*

Carbonate of lime,	98.30
Carbonate of magnesia,	a trace
Alumina and oxide of iron,	none
Insoluble matter,	1.30
Water,	0.40
	100.00

Limestone from eight miles east of Pine Grove, Schuylkill county. Color dull lead blue; texture somewhat coarse, sub-crystalline, sparry; fracture irregular, angular.

Composition in 100 *parts:*

Carbonate of lime,	49.90
Corbonate of magnesia,	7.10
Alumina and oxide of iron,	6.30
Insoluble matter,	36.30
Water,	0.40
	100.00

LIMESTONE from lower band on river road, six miles above Delaware Water Gap. Color grey; coarse, sparry, crystalline; fracture irregular, angular.

Composition in 100 *parts:*

Carbonate of lime,	81.95
Carbonate of magnesia,	none
Alumina and oxide of iron,	3.10
Insoluble matter,	14.60
Water,	0.50
Excess,	0.15
	100.00

Limestones from F. VIII.

LIMESTONE from McMickle's creek, Stroudsburg. Color dull slate blue; moderately compact; grain fine, sub-crystalline; fracture conchoidal, angles sharp.

Composition in 100 *parts:*

Carbonate of lime,	83.30
Carbonate of magnesia,	7.22
Alumina and oxide of iron,	traces
Insoluble matter,	9.98
Water,	0.50
	100.00

LIMESTONE from Karthaus, Clearfield county. Color blue; compact; fracture slightly conchoidal, angular.

Composition in 100 *parts:*

Carbonate of lime,	48.89
Carbonate of magnesia,	2.03
Alumina and oxide of iron,	5.18
Insoluble matter,	43.18
Water,	0.72
	100.00

LIMESTONE from Shamokin Coal Company's lands, Northumberland county. Color dull brownish grey; texture somewhat slaty; grain moderately fine; weathered surface ochreous brown; fracture somewhat conchoidal.

Composition in 100 *parts:*

Carbonate of lime,	71.32
Carbonate of magnesia,	7.48
Alumina and oxide of iron,	2.80
Insoluble matter,	17.80
Water and organic matter,	0.60
	100.00

Limestones from Formation XIII.

LIMESTONE from John Weines's, Muddy Creek township, Butler county. Dove colored; texture compact, close grained; fracture smooth and slightly conchoidal; surface fossiliferous, containing encrinal impressions.

Composition in 100 *parts:*

Carbonate of lime,	96.10
Carbonate of magnesia,	none
Alumina and oxide of iron,	1.30
Insoluble matter,	2.30
Water,	0.30
	100.00

LIMESTONE from Madison furnace, used as a flux, Clarion county. General character and appearance same as the above.

Composition in 100 *parts:*

Carbonate of lime,	96.90
Carbonate of magnesia,	none
Alumina and oxide of iron,	0.50
Insoluble matter,	2.30
Water,	0.30
	100.00

Limestone from upper bed, on Sugar creek, Armstrong county. Color bluish grey; compact, in parts semi-crystalline; fracture somewhat conchoidal.

Composition in 100 *parts:*

Carbonate of lime, - - - - - -	94.00
Carbonate of magnesia, - - -	none
Alumina and per oxide of iron, - - -	1.30
Insoluble matter, - - - - - -	4.30
Water, - - - - - - - -	0.40
	100.00

Limestone from Rockland furnace, Venango county. Color greyish drab; texture compact, fine grained; fracture conchoidal; faint traces of fossils.

Composition in 100 *parts:*

Carbonate of lime, - - - - - -	84.25
Carbonate of magnesia, - - - -	none
Alumina and per oxide of iron, - - -	1.00
Insoluble matter, - - - - - -	12.80
Water, - - - - - - - -	0.45
Loss - - - - - - - - -	1.50
	100.00

From the composition of some of the above limestones when compared with those known to furnish hydraulic cements, there is every reason to believe that they are well adapted to this purpose.

The recent discovery made by my brother, Professor William B. Rogers, that *most of the older limestones of the U. S. abound in magnesia;* and that these magnesian limestones *yield a lime capable of hardening under water*, is an additional inducement for undertaking an extensive chemical analysis of our calcareous rocks. For the purpose of exhibiting the close identity in composition between many of our magnesian limestones and those of Virginia and elsewhere, which have been found to be eminently hydraulic, I have transcribed a few analyses from the Report on the Geological Survey of Virginia for the year 1838.

Limestone from near Sheppardstown, on the Potomac, Virginia; extensively manufactured into cement.

Composition in 100 *parts:*

Carbonate of lime,	55.80
Carbonate of magnesia,	39.20
Alumina and oxide of iron,	1.50
Silica and insoluble matter,	2.50
Water,	0.40
Loss,	0.60
	100.00

Limestone from the Natural bridge and banks of Cedar creek, Virginia. Makes a good hydraulic cement.

Composition in 100 *parts:*

Carbonate of lime,	53.23
Carbonate of magnesia,	41.00
Alumina and oxide of iron,	0.80
Insoluble matter,	2,80
Water,	0.40
Loss,	1.77
	100.00

Limestone from Formation II., New York, extensively burnt for cement.

Composition in 100 *parts:*

Carbonate of lime,	48.20
Carbonate of magnesia,	35.76
Alumina and oxide of iron,	1.20
Insoluble matter,	12.10
Water,	2.73
Loss,	0,01
	100.00

Limestone from Louisville, Kentucky, said to make a good cement.

Composition in 100 *parts:*

Carbonate of lime,	55.03
Carbonate of magnesia,	24.16
Alumina and oxide of iron,	2.60
Insoluble matter,	15.30
Water,	1.20
Loss,	1.71
	100.00

The valuable property of magnesian limestones of making a cement which hardens under water, was first hinted at by M: Vicat, of France, but its dependence on the magnesia was not shewn until the analyses and experiments of my brother conclusively established the fact.

All which is respectfully submitted.

HENRY D. ROGERS.

Philadelphia, *February* 1 1841.

GLOSSARY

OF

GEOLOGICAL AND OTHER SCIENTIFIC TERMS EMPLOYED IN THIS REPORT.

EXTRACTED FROM LYELL'S PRINCIPLES OF GEOLOGY.

Alluvium. Earth, sand, gravel, stones, and other transported matter which has been washed away and thrown down by rivers, floods, or other causes, upon land not *permanently* submerged beneath the waters of lakes or seas. *Etym. alluo*, to wash upon.

Anticlinal Axis. If a range of hills, or valley, be composed of strata, which on the two sides dip in opposite directions, the imaginary line that lies between them, towards which the strata on each side rise, is called the anticlinal axis. In a row of houses with steep roofs facing the south, the slates represent inclined strata dipping north and south, and the ridge is an east and west anticlinal axis.

Argillaceous. Clayey, composed of clay. *Etym. argilla*, clay.

Bitumen. Mineral pitch, of which the tar-like substance which is often seen to ooze out of the Newcastle coal when on the fire, and which makes it cake, is a good example. *Etym. bitumen*, pitch.

Bituminous Shale. An argillaceous shale, much impregnated with bitumen, which is very common in the coal measures.

Calcareous Rock. Limestone. *Etym. calx*, lime.

Calcareous Spar. Crystallized carbonate of lime.

Carbon. An undecomposed inflammable substance, one of the simple elementary bodies. Charcoal is almost entirely composed of it. *Etym. carbo*, coal.

Carbonate of Lime. Lime combines with great avidity with carbonic acid, a gaseous acid only obtained fluid when united with water, —and all combinations of it with other substances are called *Carbonates.* All limestones are carbonates of lime, and quick lime is obtained by driving off the carbonic acid by heat.

Carboniferous. A term usually applied, in a technical sense, to an ancient group of secondary strata, but any bed containing coal may be said to be carboniferous. *Etym. carbo,* coal, and *fero,* to bear.

Chert. A siliceous mineral, nearly allied to calcedony and flint, but less homogeneous and simple in texture. A gradual passage from chert to limestone is not uncommon.

Coal Formation. This term is generally understood to mean the same as the Coal Measures. There are, however, "coal formations" in all the geological periods, wherever any of the varieties of coal form a principal constituent part of a group of strata.

Conformable. When the planes of one set of strata are generally parallel to those of another set which are in contact, they are said to be conformable.

Conglomerate or Puddingstone. Rounded water-worn fragments of rock, or pebbles, cemented together by another mineral substance, which may be of a siliceous, calcareous, or argillaceous nature. *Etym. con,* together, *glomero,* to heap.

Crop Out. A miner's or mineral surveyor's term, to express the rising up or exposure at the surface of a stratum or series of strata.

Crystalline. The internal texture which regular crystals exhibit when broken, or a confused assemblage of ill-defined crystals. Loaf-sugar and statuary-marble have a *crystalline* texture.—Sugar-candy and calcareous spar are crystallized.

Denudation. The carrying away by the action of running water of a portion of the solid materials of the land, by which inferior rocks are laid bare. *Etym. denudo,* to lay bare.

Diluvium. Those accumulations of gravel and loose materials which, by some geologists, are said to have been produced by the action of a diluvial wave or deluge sweeping over the surface of the earth. *Etym. diluvium,* deluge.

Dip. When a stratum does not lie horizontally, but is inclined, the point of the compass towards which it sinks is called the dip of the stratum, and the angle it makes with the horizon is called the angle of dip or inclination.

Encrini. (plural of encrinus) Marine animal bodies, having a long jointed stem, the joints somewhat resembling small buttons with a central perforation. These abound in the lower secondary rocks.

Fault, in the language of miners, is the sudden interruption of the continuity of strata in the same plane, accompanied by a crack or fissure, varying in width from a mere line to several feet, which is generally filled with broken stones, clay, &c.

Ferruginous Anything containing iron. *Etym. Ferrum*, iron.

Formation. A group, whether of alluvial deposits, sedimentary strata, or igneous rocks, referred to a common origin or period.

Fossil. All minerals used to be called fossils, but geologists now use the word only to express the remains of animals and plants found buried in the earth. *Etym. fossilis*, any thing that may be dug out of the earth.

Gneiss. A stratified primary rock, composed of the same materials as granite, but having usually a larger proportion of mica, and a laminated texture. The word is a German miner's term.

Gypsum, a mineral composed of lime and sulphuric acid, hence called also *sulphate* of *lime.* Plaster and stucco are obtained by exposing gypsum to a strong heat. It is found so abundantly near Paris, that Plaster of Paris, is a common term in this country for the white powder of which casts are made.

Laminæ. Latin for plates; used in geology, for the smaller layers of which a stratum is frequently composed.

Mica. A simple mineral, having a shining silvery surface, and capable of being split into very thin elastic leaves or scales. It is often called *talc* in common life, but mineralogists apply the term talc to a different mineral. The brilliant scales in granite are mica. *Etym. mico*, to shine.

Organic Remains. The remains of animals and plants (*organized* bodies) found in a fossil state.

Oxide. The combination of a metal with oxygen; rust is oxide of iron.

Oxygen. One of the constituent parts of the air or the atmosphere; that part which supports life. For a further explanation of the word, consult elementary works on chemistry.

Producta. An extinct genus of fossil bivalve shells, occurring only in the older secondary rocks. It is closely allied to the living genus Terebratula.

Pyrites. (Iron.) A compound of sulphur and iron, found usually in yellow shining crystals like brass, and in almost every rock stratified and unstratified. The shining metallic bodies, so often seen in common roofing slate, are a familiar example of the mineral.

Quartz. A German provincial term, universally adopted in scientific language, for a simple mineral composed of pure silex, or earth of flints: rock-crystal is an example.

Sandstone. Any stone which is composed of an agglutination of grains of sand, whether calcareous, siliceous, or of any other mineral nature.

Seams. Thin layers which separate two strata of greater magnitude.

Secondary Strata. An extensive series of the stratified rocks which compose the crust of the globe, with certain characters in common, which distinguish them from another series below them, called *primary*, and from a third series above them called *tertiary*.

Shale. A provincial term, adopted by geologists, to express an indurated slaty clay. *Etym.* German *schalen*, to peel, to split.

Shingle. The loose and completely water-worn gravel on the sea shore.

Silex or Silica. The name of one of the pure earths, being the Latin word for *flint*, which is wholly composed of that earth.

Siliceous. Of or belonging to the earth of flint. *Etym. silex.* which see. A siliceous rock is one mainly composed of silex.

Stalactite. When water holding lime in solution deposits it as it drops from the roof of a cavern, long rods of stone hang down like icicles, and these are called *stalactites*.

Stalagmite. When water holding lime in solution drops on the floor of a cavern, the water evaporating leaves a crust composed of layers of limestone; such a crust is called *stalagmite*, in opposition to *stalactite*, which see.

Strata, Stratum. When several rocks lie like the leaves of a book, one upon another, each individual forms a *stratum*;—strata is the plural of the word. *Etym. stratum*, part of a Latin verb, signifying to strew or lay out.

Strike. The direction or line of bearing of strata, which is always at right angles to their prevailing dip.

Synclinal Axis. When the strata dip in opposite directions *towards* a common central imaginary line, it is called a synclinal line or axis.

Thin out. When a stratum, in the course of its prolongation in any direction, becomes gradually less in thickness, the two surfaces approach nearer and nearer; and when at last they meet, the stratum is said to thin out, or disappear.

Zoophytes. Corals, sponges, and other aquatic animals allied to them, so called because, while they are the habitation of animals, they are fixed to the ground, and have the forms of plants. From two Greek words signifying animal and plant.

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